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Supplement 69

## Plant Diseases in Montana in 1928

May 15, 1929

BUREAU OF
PLANT INDUSTRY

UNITED STATES DEPARTMENT OF AGRICULTURE

Sugar [illegible] Diseases

[illegible] Maruv'ev, V. V. [illegible] der Zuckerrübe. Bolezni Rast. (Morbi P[illegible] [illegible], 1928.

[illegible] Nichols, S. B. [illegible] Hopkins. Delayed thinning as a means of [illegible] damping-off of sugar beets. (Abstract) [illegible], Jan. 1929.

[illegible] -127.

[illegible] sugar-beet. [illegible]

[illegible] per) 1928, [illegible] 4: 21-23. 1928. (German summary.)

[illegible], G., and [illegible] Predisposition of sugar-beets to late [illegible] Phytopath. 18: 263-276. 1928.

[illegible], C. M. [illegible] studies on the dry-rot canker of sugar beets. [illegible] Phytopath. 19: [illegible] Jan. 1929.

# PLANT DISEASES IN MONTANA IN 1928

A report of a plant disease survey made
by the Botany Department of the Montana
Agricultural Experiment Station, cooperating
with the Office of Mycology and Disease Survey
of the United States Bureau of Plant Industry

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Supplement 69

May 15, 1929.

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## INTRODUCTION

This report on a preliminary survey of the plant diseases of Montana is based chiefly on field surveys by the authors made between May 15 and October 1, 1928.

The main agricultural districts were visited one or more times, but the following of the 55 counties in the state were not entered: Beaverhead, Glacier, Lincoln, Toole, Liberty, Pondera, Teton, and Powder River. The authors drove more than 8,000 miles in automobiles, and collected about 1,200 specimens and a large amount of information. Duplicates of most of the specimens were sent to the United States Department of Agriculture, Office of Mycology and Disease Survey. Special attention was given to small grains, alfalfa and beans.

While this report is primarily for 1928, all available records and observers were consulted in order to include all the parasites and diseases known to occur in Montana, and to give the available history of the serious diseases. This information has not been previously assembled. Many of the diseases were listed by Anderson, et al (1926) in U. S. Department of Agriculture Bulletin 1366. Plant disease surveys somewhat like this one were conducted in 1927 by Linford (1928) in Utah and Archer (1928) in Iowa.

The summers in Montana are semi-arid and sometimes very dry. This condition is shown in figures by Burke and Pinkney (1919) from which the following averages are taken. Good agricultural regions in Montana have more rain than is indicated by these figures.

Driest season. 4 inches of rain during growing season; total 11 in.
Average season. 7 inches of rain during growing season; total, 15 in.
Wettest season. 11 inches of rain during growing season; total, 19 in.
Growing seasons are usually short and relatively cool.

In this climate, therefore, plant parasites are less abundant than in more humid regions supporting more abundant vegetation. Rusts, virus diseases, and physiological abnormalities are abundant in Montana. The serious diseases in the state are especially indicated in the table of contents, besides being discussed in the text.

This report considers 435 parasitic diseases, 29 virus diseases, and 34 non-parasitic diseases of 95 species and varieties of economic plants in Montana. A host index including 1075 diseases of non-economic plants in Montana has been prepared separately. These 1573 listed parasites and diseases occur on 831 species and varieties of plants. Card indexes of these plant diseases and parasites have been prepared and arranged on the basis of hosts and parasites.

Professor D. B. Swingle, who has observed plant diseases in Montana during the last 22 years, pointed out that some dangerous parasites on Montana crops now appear to be unadapted to do serious damage here, although they are occasionally introduced. Examples are bean anthracnose and cherry brown rot which have not been reported for many years, although they were once locally abundant.

The acreage, total yield, and value of crops on December 1, 1928 given herein were estimated by J. G. Diamond, Senior Agricultural Statistician, U. S. Bureau of Agricultural Economics, cooperating with the Montana State Division of Publicity at Helena, Montana.

Besides those indicated in "Literature Cited", the authors wish to acknowledge the aid of the following people who collected and classified Montana fungi and furnished other information: Dr. H. M. Jennison, Dr. J. C. Arthur, and Dr. H. S. Jackson (North American Flora), Dr. H. B. Humphrey, J. W. Blankinship, R. B. Streets, E. R. Norris, W. W. Diehl, Vera K. Charles, Florence Hedges, Dr. C. L. Shear, et al. The exsiccati of Elam Bartholomew (Fungi Columbiani), David Griffiths (West American Fungi), and A. B. Seymour and F. S. Earle (Economic Fungi) were used to the extent of their availability.

Brief references are made to reporters of many fungi considered here. In these, "U. S. Bulletin 1366" refers to this bulletin by Anderson, et al. (1926) as mentioned in "Literature Cited". "N.A.F." refers to volumes of the North American Flora by Arthur (1907-1927).

References to diseases pertain to 1928 unless otherwise stated.

Many names of host plants were taken from Bailey's Manual of Cultivated Plants and the New Manual of Rocky Mountain Botany by Coulter and Nelson. Names of parasites and other hosts were taken from U. S. Bureau of Plant Industry Bulletin 1366 and articles mentioned in "Literature Cited".

## NEW DISEASES AND ORGANISMS IN MONTANA

According to available records, the following diseases and parasites, except some that were reported in brief survey notes are here reported as occurring in Montana for the first time. This list is probably incomplete. A new disease is defined as a new combination of a species of a host with a species of parasite or virus, or physiological abnormality not previously reported on the host.

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| | Leaf girdle | 132 |
| Bean: | Calico | 138 |
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| Lima bean: | Phytomonas phaseoli | 138 |
| Loganberry: | Mosaic | 160 |
| Millet: | Pseudomonas alboprecipitans | 134 |
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| Oats: | Colletotrichum graminicolum | 130 |
| | Phytomonas coronafaciens | 129 |
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| Potato: | Curly mosaic | 144 |
| Pea: | Ascochyta pinodella | 140 |
| | Fusarium orthoceras pisi | 140 |
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| | | |
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| Plum: | Phytomonas pruni | 158 |
| Poplar: | Blight (undetermind) | 167 |
| | Chlorosis | 168 |
| | Phytomonas tumefaciens | 168 |
| | Diatrype bullata | 168 |
| Raspberry: | Didymosphaeria manitobensis | 159 |
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| Rose: | Ameris rosicola | 165 |
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| Sorghum: | Bacterium holci | 133 |
| | Translucent bacterial stripe (unnamed) | 133 |
| Strawberry: | Bacterial leaf spot (undetermined) | 161 |
| | Sphaerotheca humuli | 161 |
| | Mycosphaerella fragariae | 161 |
| | Yellowing (Xanthosis?) | 160 |
| Sudan grass: | Bacterium holci | 134 |
| Sweet clover: | Albinism | 151 |
| | Mosaic | 151 |
| | Septoria meliloti | 151 |
| Sweet corn: | Cephalosporium acremonium | 133 |
| Tobacco: | Witches' broom | 146 |
| Tomato: | Alternaria solani | 145 |
| | Fusarium lycopersici | 145 |
| Vetch: | Kabatiella nigricans | 155 |
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| | Lachnella flammea | 168 |
| | Marssonia apicaulis | 168 |
| | Septogloeum maculans | 168 |
| | Septoria salicis | 168 |
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## CEREAL AND GRASS CROPS

### WHEAT (*Triticum aestivum L.*)

Winter wheat. 1928. 810,000 acres. 12,150,000 bushels. Worth $9,760,000.
Spring wheat. 1928. 3,410,000 acres. 64,790,000 bushels. Worth $54,424,000.

(Table 42 summarizes losses in wheat).

STINKING SMUT OR BUNT (Tilletia laevis Kuehn). Stinking must is the most destructive plant disease in Montana and will probably remain so. It is conservatively estimated to have caused a loss of more than one million dollars in Montana in 1928. The basis for estimating this loss is as follows:

Losses in yield:

| | |
|---|---|
| 3.6% or 437,400 bu. winter wheat at 80 cents per bu. .......... | $349,920. |
| 0.63% or 408,177 bu. spring wheat at 80 cents per bu. ......... | 326,541. |
| Loss by dockage (as in Table35) 9,463,620 bu. at 4 cents per bu. | 378,545. |
| Total dockage and yield losses | $1,055,006. |

To this last figure there might be added the cost of chemicals and labor used in treating seed wheat on a large scale but this amount is not known. Many growers use treating machines.

## Field Losses

Special effort was made to determine the amount of stinking smut in Montana wheat fields. The above estimates are based largely on field inspections made in the counties indicated in Figure 2. The winter wheat was nearly all Turkey Red wheat and its subvarieties (except 2 fields of Crail Fife wheat). The spring wheat was mostly Marquis.

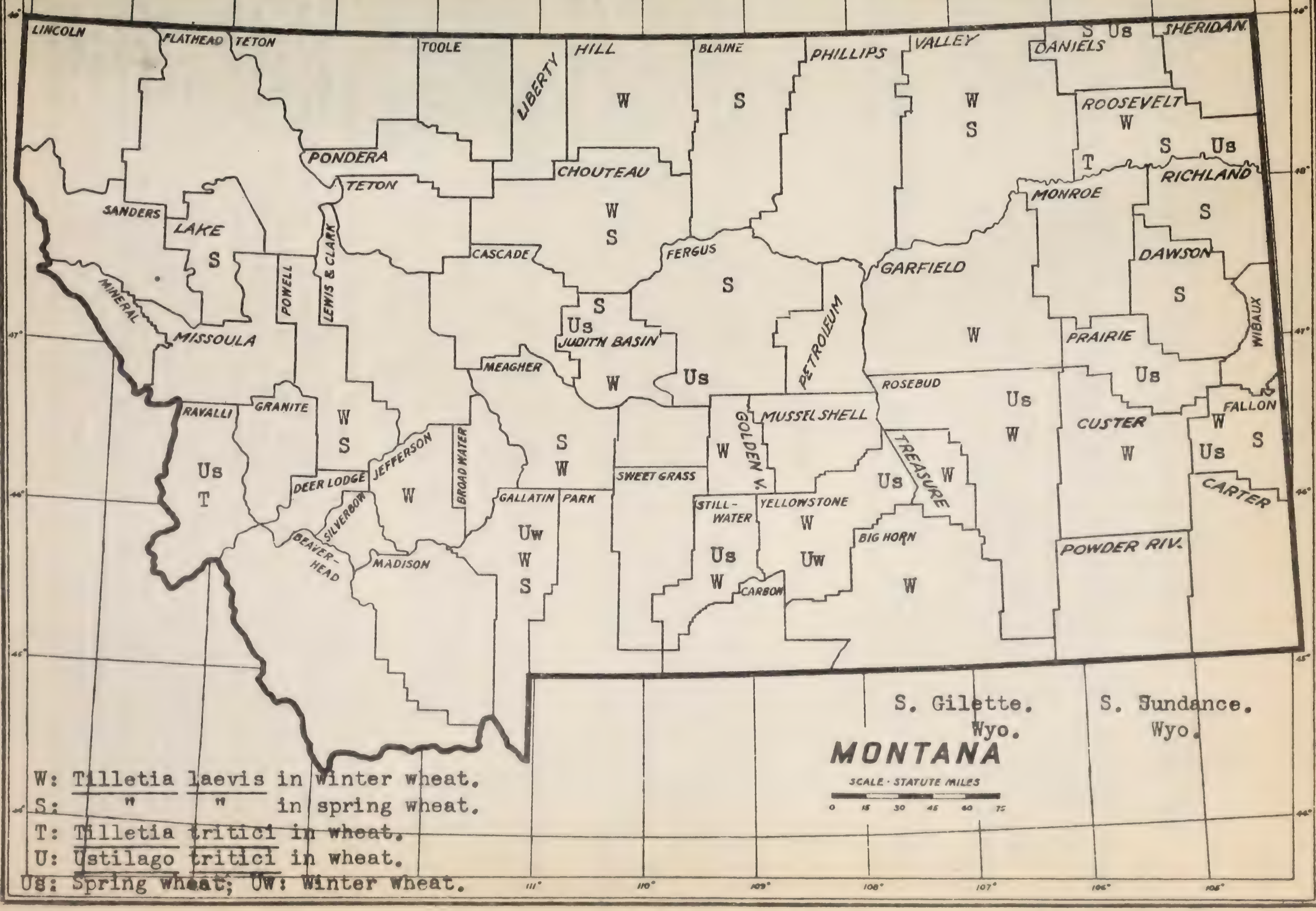
Winter wheat - 180 fields; 20,050 acres; average 3.6 per cent bunt.
Spring wheat - 55 fields; 9,930 acres; average 0.63 per cent bunt.

Some fields of winter wheat contained 25 to 60 per cent bunt and some fields of spring wheat contained 5 to 17 per cent bunt. The infestation of stinking smut was less in spring than in winter wheat because the bunt spores do not overwinter in the soil to an economic extent. Bunt was serious in spring wheat only in regions producing smutty winter wheat. In such places, some extra inoculation of spring wheat occurs in threshing, etc.

Many observations and experiments have shown that the spores of Tilletia laevis in the soil are important sources of infection of winter wheat in Gallatin and some other counties. The treated winter wheat in this region averaged 10 to 25 per cent stinking smut in 1927 and 1928, in comparison to 52 to 92 per cent in untreated wheat, so soil infestation is a serious factor. Volunteer, harvested stands of wheat, sowed by destruction of the parent crops by hail, contained no bunt or only traces of it, even when the parent crops contained more than 1 per cent of bunt. Probably little inoculation and early planting accounts for this.

Comparative Data for 1927. In the northern part of Gallatin Valley, 43 fields of Turkey Red wheat aggregating 1100 acres were inspected. The average percentage of stinking smut (Tilletia laevis) was 7.4 per cent. One field of 150 acres on badly infested soil contained an average of 23 per cent of stinking smut based on a count of 4300 heads. All the seed in this field had been

Fig. 2. Smuts of Wheat in Montana, 1928.



W: Tilletia laevis in winter wheat.
S: " " in spring wheat.
T: Tilletia tritici in wheat.
U: Ustilago tritici in wheat.
Us: Spring wheat; Uw: Winter wheat.

treated. One-third of the field with seed treated with 50 per cent $CuCO_3$ averaged 19 per cent bunt. Prevalence of bunt in other fields on this farm in 1928 was very similar to that in 1927.

Species of Tilletia in Montana Wheat. Specimens from 56 fields of winter and spring wheat were examined microscopically. All but three were Tilletia laevis. Two specimens of durum wheat from Roosevelt County, and one specimen of Marquis wheat from Ravalli County were Tilletia tritici (Bjerk.) Wint. In Roosevelt County, 100 acres of durum wheat contained 25 per cent of the heads with T. tritici. Further spread of T. tritici is liable to occur in Montana. It was found in spelt at Gustave, South Dakota, which is near the Montana line.

Tilletia laevis was found in the following varieties of wheat: Turkey Red, Montana 36, New Turk, Karmont, Kharkof, Crail Fife, Club hybrid 128, Kota, Burbank Super, Marquis, Supreme, Red Bobs and Ruby.

## Dockage

Figures 3 and 4 and Tables 35, 36 and 37 show the stinking smut in cars of Montana wheat received at Minneapolis, Minnesota and Portland, Oregon. At these terminals, cars of wheat are graded as smutty or not smutty. Figures on smut dockage per car are not available. Very valuable information on amounts of smut dockage per car could be secured readily at the terminal elevators. It is hoped that hereafter grain supervisors will be instructed to secure such information thoroughly and completely, or that other organizations will be provided for acquiring it.

Calculations of Smut Dockage by Wheat Buyers. Since a relatively small percentage of the people interested in smut dockage know how it is calculated or estimated, the methods now used are explained here. Much of the following information was kindly supplied by Professor W. O. Whitcomb, Superintendent of the Grain Laboratory, Montana Agricultural Experiment Station, Mr. R. B. Whitlock, Federal Grain Supervisor at Portland, Oregon and Mr. R. C. Miller, Grain Inspector at Minneapolis, Minnesota.

Farmers pay the entire loss due to smut in wheat, for smut dockage is large enough to make it safe and even attractively profitable for buyers to deal in smutty wheat. Although buyers sometimes use "horse-trading" methods in purchasing very smutty wheat, smut dockages are usually estimated by the methods given in the "Handbook of Official Grain Standards" by Boerner (1924). Section (a) is followed at Portland and section (b) is followed at Minneapolis.

Removal of smut by washing instead of scouring has developed greatly during the last three years. Washed wheat gains a little weight instead of losing weight like scoured wheat, which lowers the test weight. However, the gain is slight for grain is washed quickly in cold water and is dried before much absorption occurs. Very smutty wheat sometimes acquires a rancid odor in storage after washing. Wheats with wrinkled bran coats become badly wrinkled after washing. Most of the wheat milled on the Pacific Coast is scoured or washed first because smutty wheat is so common. Wheat for export is scoured in case it is smutty. Some wheat is exported as "sample grade", without inspection, but such shipments of sample wheat rarely have more than 0.5 per cent smut.

Black point and similar discolorations due to bacteria, Helminthosporium, and some other dematiaceous fungi have been confused with discolorations caused by bunt.

The dampness of wheat and bunt at threshing time affects the dockage on the threshed grain, for the spores in damp smut balls are smeared onto the grain, while dry smut balls contaminate wheat by powdered spores and large parts of smut balls, and thus are less injurious than damp smut balls.

Calculation of Smut Dockage at Portland, Oregon. At Portland where smutty wheat is handled in large quantities, smut dockage is calculated by running a 500 gram sample through a dockage tester which grinds off the surface of the grain in removing the smut. The dockage is computed on the basis of loss in weight of the sample. Thus, a dockage of 1 per cent is made for each 5 grams that the sample loses weight. Slightly smutty wheat is cleaned by a single passage through a dockage tester, while badly smutty wheat is run through the dockage tester or scouring mill two or more times before it is cleaned, which increases the dockage because each time it passes through the mill, more of the grain is ground off in removing the smut. Smut dockage is subtracted after deduction for foreign material has been made. Commercially, the work of the dockage tester is done in a cleaning mill. A fixed smutting charge (cleaning charge) is made per ton based upon the smut dockage (see schedule below).

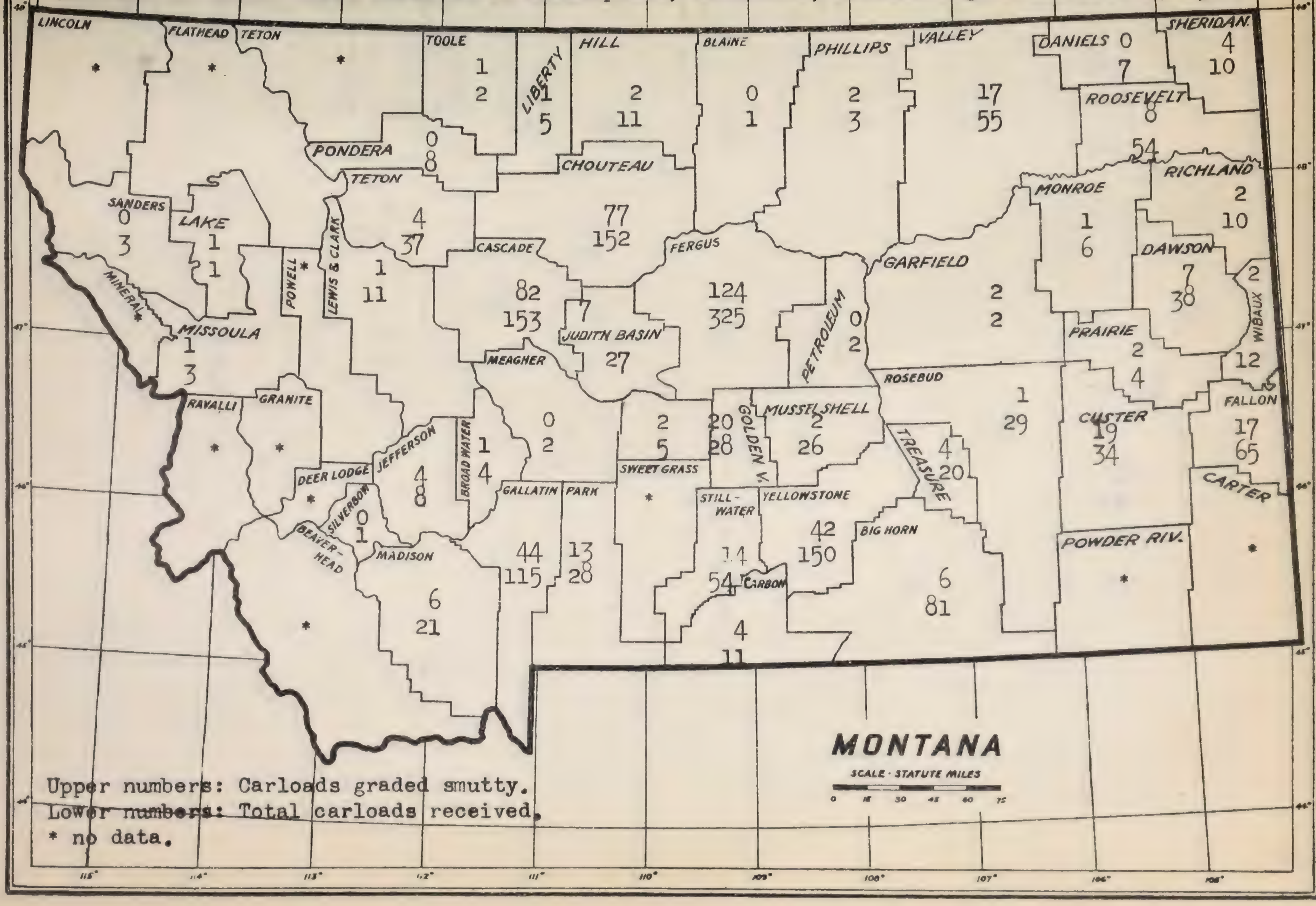
Important elevators use the following schedule (Table 34) prepared by the Merchants Exchange of Portland. This may not correspond exactly to schedules used by other concerns.

Table 34 Schedule - Cleaning Charges for Smutty Wheat at Portland, Oregon.

| Smut dockage as determined by dockage tester (per cent) | Smutting charges (dollars per ton) | |
|---|---|---|
| | Sacked Grain | Bulk Grain* |
| 0.5 to 1. | 0.75 | 0.45 |
| 1.5 to 3. | 0.80 | 0.50 |
| 3.5 to 7. | 1.10 | 0.80 |
| 7.5 to 15. | 1.30 | 1.00 |

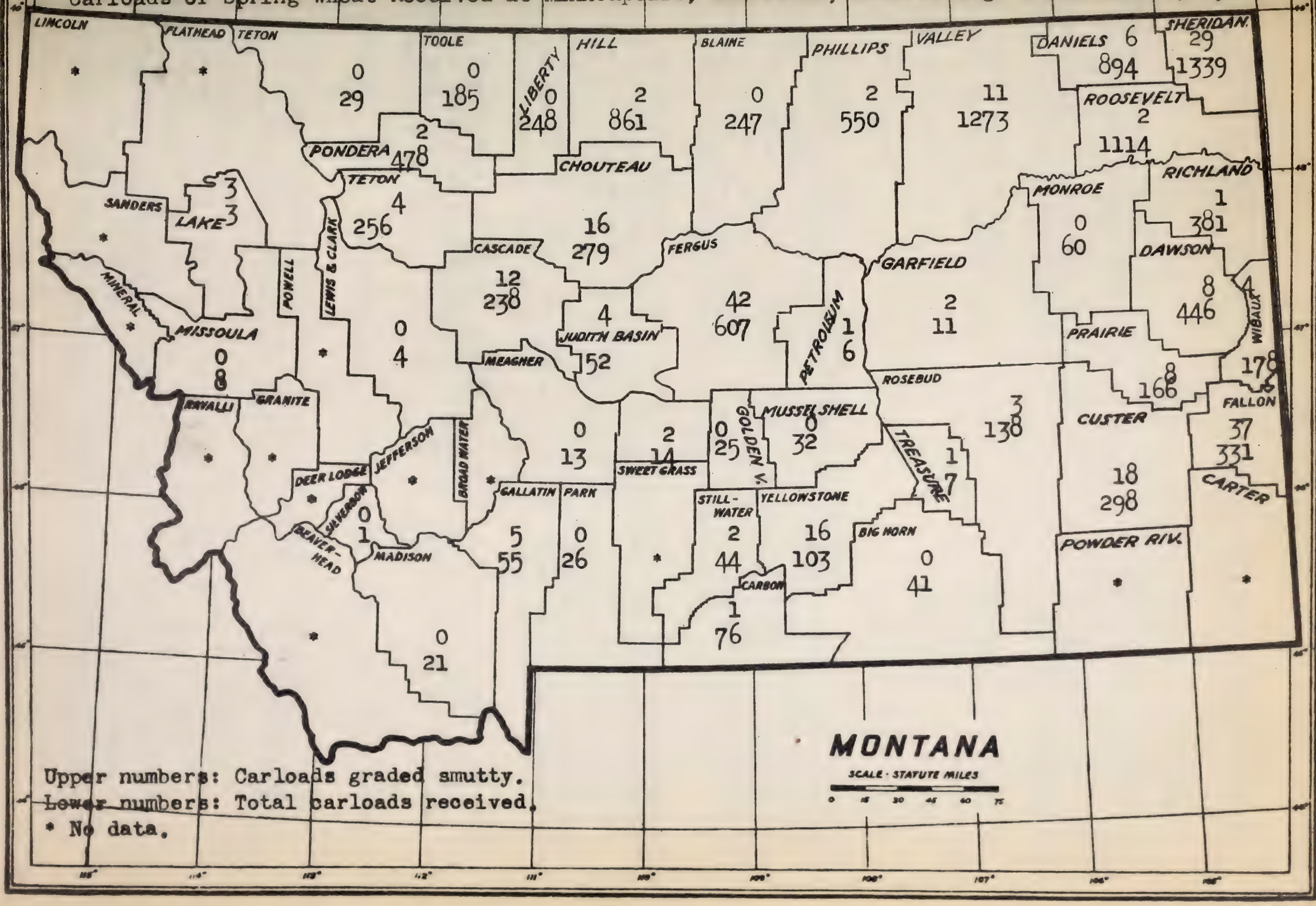
*Three cents per bushel are deducted for bulk grain for storage and handling.

Fig. 3. Stinking Smut of Winter Wheat in Montana,
Carloads of Winter Wheat Received at Minneapolis, Minnesota, Between Aug. 1 and Dec. 1, 1928.



Upper numbers: Carloads graded smutty.
Lower numbers: Total carloads received.
* no data.

Fig. 4. Stinking Smut in Spring Wheat in Montana, Carloads of Spring Wheat Received at Minneapolis, Minnesota, Between Aug. 1 and Dec. 1, 1928.



Upper numbers: Carloads graded smutty.
Lower numbers: Total carloads received.
* No data.

Example: Calculated price of a car of sacked smutty wheat versus clean sacked wheat at Portland.

| | Smutty | Clean |
|---|---|---|
| Total amount of wheat | 100,000 lb. | 100,000 lb. |
| 1% dockage for foreign material, weed seeds, dirt, etc. | 1,000 lb. | 1,000 lb. |
| 2% smut dockage, determined by dockage tester | 1,980 lb. | |
| Wheat after subtracting dockages | 97,020 lb. | 99,000 lb. |
| Value at 80 cents a bushel | $1,293.60 | $1,320.00 |
| Subtract smutting charge** | 39.60 | |
| Actual sale price | $1,254.00 | $1,320.00 |
| Difference (loss) | $66.00 (about 5%). | |

Estimating Price of Smutty Wheat at Minneapolis. Wheat is graded smutty on the basis of paragraph (b) in the standards (Boerner, 1924) relative to the grading of smutty wheat. Buyers estimate the amount of smut by sight and odor as slight, medium, and very smutty. There is a daily variation in smut dockages made by this method. The variable factors are: (1) smut predominating as smut balls; (2) smut predominating as spores smeared onto the wheat; and (3) the amount and degree of contamination of smutty wheat on the market.

In 1928, wheat with traces of smut (line grade for smut) was discounted 1 to 3 cents per bushel. Most smutty wheat was docked 2 to 5 cents per bushel. Wheat with heavy smut was docked 7 to 10 cents per bushel. Scouring and washing was done by commercial flour milling companies and two elevators which merchandised smutty wheat. When they handled large quantities of smutty wheat, they made less dockage for heavily smutty wheat. Plump wheat with smut took a lower dockage than shrunken wheat equally affected with smut.

Smut Dockage at Duluth, Minnesota. There is a smut dockage of 10 to 15 cents per bushel at Duluth when much smut is received. When fewer cars of smutty wheat are received, the dockage rate is lower. This information was furnished by W. H. O'Shea, Grain Supervisor at Duluth.

Table 35. Method of estimating losses from smut dockage in Montana wheat, 1928.

| Kind of wheat and receiving point | Number of cars | |
|---|---|---|
| | Total | Graded smutty |
| Wheat - Portland | 5,168 | 1,395 |
| Spring wheat - Minneapolis | 11,170 | 272 |
| Winter wheat - Minneapolis | 1,635 | 541 |

Percentage cars graded smutty - 12.3.
12.3 per cent of 76,940,000 bushels of wheat = 9,463,620 bushels.
Dockage loss at rate of 4 cents per bushel = $378,545.

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**The smutting (milling) charge is $0.80 per ton on all the wheat after the dockage for foreign material, etc. is taken out. In this case the smutting charge is based on 99,000 pounds.

Table 36. Smutty wheat from Montana received at Portland, Oregon from July 1, 1927 to July 1, 1928. (Reported by R. L. Baldwin, Grain Supervisor).

| Shipping Point | Total Cars | Cars with Smut | Per cent Smutty |
|---|---|---|---|
| Great Falls | 6,437 | 1,259 | 19.6 |
| Bozeman | 656 | 286 | 43.6 |
| Total, 1927 crop | 7,093 | 1,545 | 21.7 |

Table 37. Smutty wheat in 1928 crop from Montana received at Portland, Oregon from July 1, 1928 to December 1, 1928. (Reported by R. L. Baldwin, Grain Supervisor).

| Shipping Point | Total Cars | Cars with Smut | Per cent Smutty |
|---|---|---|---|
| Great Falls | 2,967 | 689 | 23.2 |
| Bozeman | 456 | 197 | 43.2 |
| Harlowtown | 1,745 | 534 | 30.6 |
| Total, 1928 crop | 5,168 | 1,400 | 27.08 |

Foster (1894, 1895, and 1896), Morris and Ogaard (1925), Morris and Kurtz (1929), and Swingle (1917)described wheat bunt in Montana.

Whitcomb (1926) showed that bunt on wheat has little effect on the protein test.

LOOSE SMUT (Ustilago tritici (Pers.) Rostr.). This smut is common and widely distributed in Montana but is usually not destructive. In 1928, it was found in the counties indicated in Figure 2. Traces were found in 29 of the 42 fields inspected for it. These fields included 3,200 acres. It was not noticed in 200 other fields covering about 30,000 acres.

One field of 80 acres of spring wheat at Culbertson contained 10 per cent of loose smut. In 1927, 20 acres of Supreme wheat contained 25 per cent.

Although loose smut is sometimes destructive in wheat proposed for registration, it was not serious in 1928. Registration rules tolerate no more than 1 per cent. No fields were refused registration due to loose smut in 1928.

STEM RUST (Puccinia graminis Pers.). Puccinia graminis appeared in the wheat fields of Montana too late to do serious damage in 1928. It was found in the counties indicated in Figure 5. Some of the locations and results of field inspections were supplied by W. L. Popham, W. L. Jellison, and James Bradbury of the Barberry Eradication Project.

Stem rust was found in 11 fields of winter (mostly Turkey Red) wheat. One field in Chouteau County had 100 per cent of the stems and 3 per cent of the leaf area spotted. One field in Daniels County had 100 per cent of the stems and traces of the leaf area spotted.

One hundred and fifty fields of spring wheat,(mostly Marquis) aggregating about 8,000 acres, were inspected for Puccinia graminis. Traces or slightly more occurred in 5,600 acres. Nine fields in Chouteau, Daniels, Philips, Valley, Mineral, and Ravalli Counties showed all the stems bearing *Puccinia graminis*. The rust on the leaves varied from traces to 40 per cent. Most of the other affected fields showed only traces of stem rust.

Table 38 gives estimates of losses from *Puccinia graminis*. The decrease in losses during the last five years has probably been influenced by the destruction of more than 14,000,000 barberry bushes (including 34,089 in Montana) in the 13 wheat growing states in the Barberry Eradication Campaign.

Apparently the weather in Montana in most years is too dry to permit destructive spread of *Puccinia graminis* early enough to do great damage. Tehon and Young (1924) and Tehon (1927) showed a correlation between the weather and black stem rust.

Morris and Popham (1925, 1926) and Swingle and Morris (1907-1922) described black stem rust and barberry eradication in Montana.

Table 38. Estimated losses in wheat, oats, barley and rye, caused by Stem rust in Montana. (Courtesy of W. L. Popham, State leader, Barberry Eradication, United States Department of Agriculture).

| Year | Wheat | Oats | Barley | Rye | Total Bushels | Total Value |
|---|---|---|---|---|---|---|
| 1916 | 3,000,000 | | | | | |
| 1917 | 45,000 | 71,000 | No report | No report | 116,000 | 143,910 |
| 1918 | No report | No report | No report | No report | No report | - - |
| 1919 | 0 | No report | 0 | 0 | - - | - - |
| 1920 | 0 | Trace | Trace | Trace | Trace | - - |
| 1921 | 857,000 | 150,000 | 0 | 0 | 1,007,000 | 779,450 |
| 1922 | 0 | 0 | 0 | No report | - - | - - |
| 1923 | 10,472,000 | 0 | No report | 0 | 10,472,000 | 8,587,040 |
| 1924 | 260,000 | 0 | 0 | 0 | 260,000 | 322,400 |
| 1925 | Trace | No report | 0 | 0 | Trace | - - |
| 1926 | 46,000 | Trace | 0 | 0 | 46,000 | 50,400 |
| 1927 | 80,000 | Trace | 0 | 0 | 80,000 | 80,000 |
| 1928 | 78,000 | 0 | 0 | 0 | 78,000 | 70,000 |
| Total | 11,837,000 | 221,000 | Trace | Trace | 12,059,000 | $10,033,200 |
| Average | 986,000 | 18,000 | | | 1,049,000 | $ 989,000 |

LEAF RUST (*Puccinia triticina* Eriks.). Presumably this rust occurs in every county in the state in which large fields of wheat are grown, but is rarely serious. Figure 5 shows the known distribution of the leaf rust in 1928. Some of the locations were supplied by Mr. W. L. Popham, State Leader in Barberry Eradication, United States Department of Agriculture, and his assistants, W. L. Jellison and James Bradbury. From Table 40 it will be seen that the average percentage of leaf area destroyed was estimated at 11.8 per cent.

Turkey Red wheats appear to be less susceptible to *Puccinia triticina* than Marquis and some other varieties in Montana.

Estimation of damage caused by leaf diseases. Tehon (1927) has described a method of computing the percentage of leaf area destroyed in a field by a leaf-spotting fungus such as Puccinia triticina. By using Tehon's method, with the addition of appropriate decimal points for the sake of clearness, data from field inspections for this fungus are assembled in Tables 39 and 40.

Table 39. Puccinia triticina in wheat in Fergus County, Montana. 1928.

| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|
| County | No. of fields observed | Acres examined | Prevalence: Per cent diseased plants | | | Destructiveness: Leaf area affected | | |
| | | | Per cent | Per cent x acres | Weighted per cent | Per cent | Per cent x Column 5 | Weighted per cent |
| Fergus | 1 | 100 | 100 | 100.00 | | 10 | 10.0000 | |
| " | 1 | 160 | 100 | 160.00 | | 70 | 112.0000 | |
| " | 1 | 80 | 100 | 80.00 | | 10 | 8.0000 | |
| " | 1 | 40 | 100 | 40.00 | | 35 | 14.0000 | |
| " | 1 | 60 | 100 | 60.00 | | 85 | 51.0000 | |
| " | 1 | 20 | 100 | 20.00 | | 40 | 8.0000 | |
| " | 7 | 310 | 0.5 | 1.55 | | 0.5 | .775 | |
| " | 5 | 540 | 0 | .00 | | 0 | 0 | |
| (Total) | 18 | 1310 | | 461.55 | 35.2 | | 203.775 | 15.5 |

## Explanation of Tables 40 to 47.

The columns in Table 40 contain the same type of information as those in Table 39 except in the following details:

Relative to Columns 4 and 7. When the fields inspected in a county did not have the same percentage of diseased plants and the same percentage of leaf area destroyed, figures were not given in Columns 4 and 7. Instead, the data for such counties were summarized as in Table 39 to give the weighted percentages in Columns 6 and 9.

Relative to Column 6. Part of the inspection records from some counties gave only percentages of destructiveness. Hence no figures could be given for such counties in Columns 4, 5 and 6, nor in the summaries of these columns.

Relative to Column 9. For individual fields or subgroups, this percentage is derived by multiplying the percentages of prevalence and destructiveness (Column 4 x Column 7). This product is written in parentheses because it is not used in calculating the weighted percentage of destructiveness for the entire state or region. Parentheses are used in Column 6 for the same reason.

Although Column 9 in Table 40 gives the percentage of the leaf area destroyed by Puccinia triticina, this percentage does not directly represent reduction in yield. The correlation between reduced leaf area and reduced yield has not been determined in Montana, but observations on Puccinia triticina in southern Illinois in 1921 and 1922 indicated a commercial loss in yield and value of about 25 per cent when the weighted percentage of destructiveness was about 50 per cent. Red leaf rust is rarely if ever this severe in Montana.

Table 40. Puccinia triticinia in wheat in Montana. 1928.

| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|
| County | No. of fields observed | Acres examined | Prevalence: Per cent of diseased plants |  |  | Destructiveness: Leaf area affected |  |  |
|  |  |  | Per Cent | Per cent x acres | Weighted per cent | Per Cent | Per cent x Column 5 | Weighted per cent |
| Ravalli | 77 | 1160 | - | - | - | - | 396.70000 | (34.4) |
| Lake | 2 | 100 | 10 | 10.00 | (10) | 10 | 1.0000 | (1) |
| Missoula | 3 | 160 | - | 84.00 | (5.3) | - | .4020 | (.25) |
| Mineral | 25 | 125 | - | - | - | - | 16.4500 | (13) |
| Flathead | 1 | 2 | 100 | 2.00 | (100) | 20 | .4000 | (20) |
| Gallatin | 7 | 682 | - | 282.20 | (41.4) | - | 30.1100 | (4.4) |
| Yellowstown | 14 | 1145 | - | 379.35 | (33.1) | - | 107.6763 | (9.4) |
| Fergus | 18 | 1310 | - | 461.55 | (35.2) | - | 203.7750 | (15.5) |
| Judith Basin | 4 | 220 | - | 60.60 | (28) | - | .3030 | (.14) |
| Wheatland | 2 | 230 | - | - | - | - | .2300 | (.1) |
| Carter | 2 | 120 | 10 | 12.00 | (10) | 1 | .1200 | (.1) |
| Rosebud | 8 | 550 | - | 40.80 | (7.2) | - | 2.4110 | (.44) |
| Garfield | 2 | 70 | 0.5 | .35 | (0.5) | 0.5 | .00175 | (.0025) |
| Prairie | 4 | 190 | - | 10.75 | (6) | - | 4.0038 | (2) |
| Big Horn | 10 | 3290 | - | 2048.25 | (62.2) | - | 504.1460 | (15.3) |
| Custer | 3 | 200 | - | - | - | - | .2000 | (.1) |
| Valley | 18 | 2180 | - | 56.55 | (2.6) | - | 3.0070 | (.14) |
| Treasure | 2 | 50 | - | - | - | - | .0500 | (.1) |
| Phillips | 7 | 410 | - | - | - | - | 1.2300 | (.3) |
| Fallon | 3 | 220 | - | - | - | - | .4400 | (.2) |
| Chouteau | 14 | 1260 | - | 480.85 | (38.1) | - | 48.0040 | (3.8) |
| Dawson | 1 | 200 | 100 | 200.00 | (100) | 15 | 300.0000 | (15) |
| Richland | 1 | 200 | 100 | 200.00 | (100) | 5 | 100.0000 | (5) |
| Roosevelt | 4 | 320 | 100 | 320.00 | (100) | - | 24.40000 | (7.6) |
| Hill | 6 | 250 | - | - | - | - | .7500 | (.3) |
| Blaine | 3 | 160 | - | - | - | - | .3200 | (.2) |
| Totals | 241 | 14,804 |  |  |  |  | 1746.111 | 11.8 |

YELLOW STRIPE RUST (Puccinia glumarum (Schm.) Eriks.). Yellow stripe rust was found in the counties indicated in Figure 5. It was first found in Montana in 1915 by Dr. F. K. Ravn.

Most of the numerous fields of Jones Fife wheat in Flathead County had all of the plants affected with yellow stripe rust, from 50 to 90 per cent of the leaves being killed prematurely, according to W. L. Popham, who made a careful inspection. Glume infection was common. Raeder (1928) also reported this epidemic. This wheat yielded well even though badly infested with stripe rust.

The injurious effect of Puccinia glumarum was similar to that of P. triticina. The epidemic became severe too late to reduce the yield very seriously. It also occurred on Hordeum jubatum in Flathead County.

At Bozeman, 40 acres of Crail Fife wheat had stripe rust on all the stems in the field, about 60 per cent of the leaf tissues being destroyed. It was not seen in two other fields of Crail Fife wheat near this one. Puccinia glumarum was abundant in only the margins of the plots of Jones Fife wheat, and was not seen in other varieties of wheat on the Agricultural Experiment Station at Bozeman.

Stripe rust was abundant in an experimental plot of Crail Fife wheat at Havre. Traces were seen in fields of Marquis wheat in Hill and Chouteau Counties. It has occurred in Jones Fife wheat on the Experiment Station at Bozeman for thirteen years. In 1927, a 60 per cent leaf infestation of stripe rust was found on a velvet chaff wheat in Lake County.

Since Puccinia glumarum was not seen in Turkey Red wheat and was not serious in Marquis wheat, it does not threaten to be very destructive in Montana.

FOOT ROT (Helminthosporium sativum Pam., King, and Bakke). Specimens of wheat were sent to this laboratory from the Experiment Station at Moccasin, Montana in November, 1927. These specimens had foot rot, and bore many yellow leaves. They exemplified the fall symptoms of Helminthosporium foot rot that became epidemic in winter wheat in central Montana in 1928. Bayles and Sutherland (1928) found correlation between foot rot, drouth injury and winter killing. Young (1928) described foot rot.

In 1928, wheat before heading in many fields was chlorotic, dwarfed, upright, and had some yellow to brown leaves, brown roots, and too many stems. Mottling, streaking and leaf spotting were associated symptoms. The most severely affected fields developed so poorly that some of them were plowed without harvesting.

Severe damage in central Montana was closely correlated with early planting. This evidence supports the statements of some authors that relatively high temperatures favor infection by Helminthosporium. This correlation with early planting was observed during the epidemics of foot-rot in central Montana, about 16 years ago. Then, farmers planted wheat between July 15 and August 15. Authorities from Montana State College advocated late planting. Farmers followed this advice, and foot rot was thereafter not serious for many years.

In 1927, however, many farmers planted wheat between July 15 and August 20. That fall was unusually long and rather dry. Wheat grew too large, and seriously reduced the amount of soil moisture. Some fields showed symptoms of foot rot in the fall. Many of the early-planted fields showed severe symptoms in the spring of 1928. A temperature of -5° F. on April 13, 1928 caused unexpected winter injury. A drouth in May and early June did not permit the wheat to recover from foot rot and winter injuries. Early planted wheat developed to a stage in which it demanded much water during the drouth in May. With roots badly damaged by foot rot, such wheat became yellowed and dwarfed with many brown lower leaves at heading time. Poor cultural conditions increased the injury done by foot rot. The worst fields died prematurely instead of ripening properly, and had a gray color unlike yellow, normally ripe fields. Such fields bore low yields of shrivelled grain and the heads in some were covered with a mold which, in most cases, appeared to be Fusicladium alopecuri.

In contrast to the affected early planted fields, other fields planted early in September, 1927 had wheat that germinated in cooler soil and were only slightly injured by foot rot. It remained green during the drouth.

Wheat planted on July 15 and August 1, 1928 in plots at the Moccasin Agricultural Experiment Station was nearly dead by November 1, 1928, chiefly through the severe attack by Helminthosporium. Wheat planted on September 1, 1928 and a little later, showed very little injury by November 1. Commercial fields also exemplified these results.

According to a recent estimate by J. G. Diamond, Agricultural Statistician, Montana farmers reduced their acreage of winter wheat 40 per cent in 1928, most of which was planted around September 1. He estimated that only about 481,000 acres will be harvested in 1929. The reduction in acreage was due mainly to low prices, and losses caused by foot rot in the 1927-1928 crop.

Just as devastation of some wheat fields by Helminthosporium foot rot has been ascribed to black stem rust, so black point of kernels caused by the same fungus has been carelessly or conveniently ascribed to stinking smut. Thus, records of Helminthosporium are incomplete, and too low in their estimates of losses.

Data from field inspections are summarized in Table 41. The weighted average percentages are too large to represent the whole state because foot rot was not serious in the extensive region of spring wheat in northeastern Montana, as represented in the table by Daniels County. Daniels County was included in the table to call attention to this fact, although it made the average percentages too low to represent the winter wheat region of central Montana.

Because fields severely affected with foot rot are easily detected from a distance of more than 100 yards, and because determination of damage was the main object in this preliminary survey, records of severely affected fields predominate in Table 41.

Probably foot rot will continue to reduce yields of wheat seriously in Montana.

Table 41. Field inspections for wheat foot rot. Montana, 1928.

| County | Variety | No. of Fields | Acres | Per cent prevalence | Per cent loss |
|---|---|---|---|---|---|
| Hill | Marquis | 6 | 600 | 80 | 20 |
| Hill | Marquis | 6 | 400 | 50 | 10 |
| Chouteau | Spring | 6 | 600 | 30 | 10 |
| Roosevelt | Durum | 1 | 100 | 20 | 4 |
| Fergus | Marquis | 1 | 100 | 20 | 5 |
| Fergus | Turkey Red | 10 | 800 | 70 | 20 |
| Fergus | Turkey Red | 3 | 380 | 50 | 10 |
| Fergus | Turkey Red | 1 | 15 | 100 | 85 |
| Fergus | Turkey Red | 1 | 40 | 50 | 25 |
| Judith Basin | Turkey Red | 7 | 900 | 5 | 1 |
| Judith Basin | Turkey Red | 1 | 100 | 50 | 15 |
| Judith Basin | Turkey Red | 1 | 40 | 100 | 100 |
| Judith Basin | Turkey Red | 2 | 100 | 100 | 85 |
| Gallatin | Turkey Red | 2 | 10 | 100 | 50 |
| Daniels | Marquis | 30 | 5000 | 0 | 0 |
| Rosebud | Marquis | 1 | 200 | 5 | 1 |
| Cascade | Winter | 100 | 10000 | 75 | 25 |
| 9 Counties |  | 179 | 19385 | 48.7 | 11.8 |

Averages computed as in Table 40, but acreage-percentage products omitted.

BLACK CHAFF (Bacterium translucens undulosum S., J., & R.). This disease is common in the eastern half of Montana, but usually is not serious. Figure 5 shows its distribution in 1928.

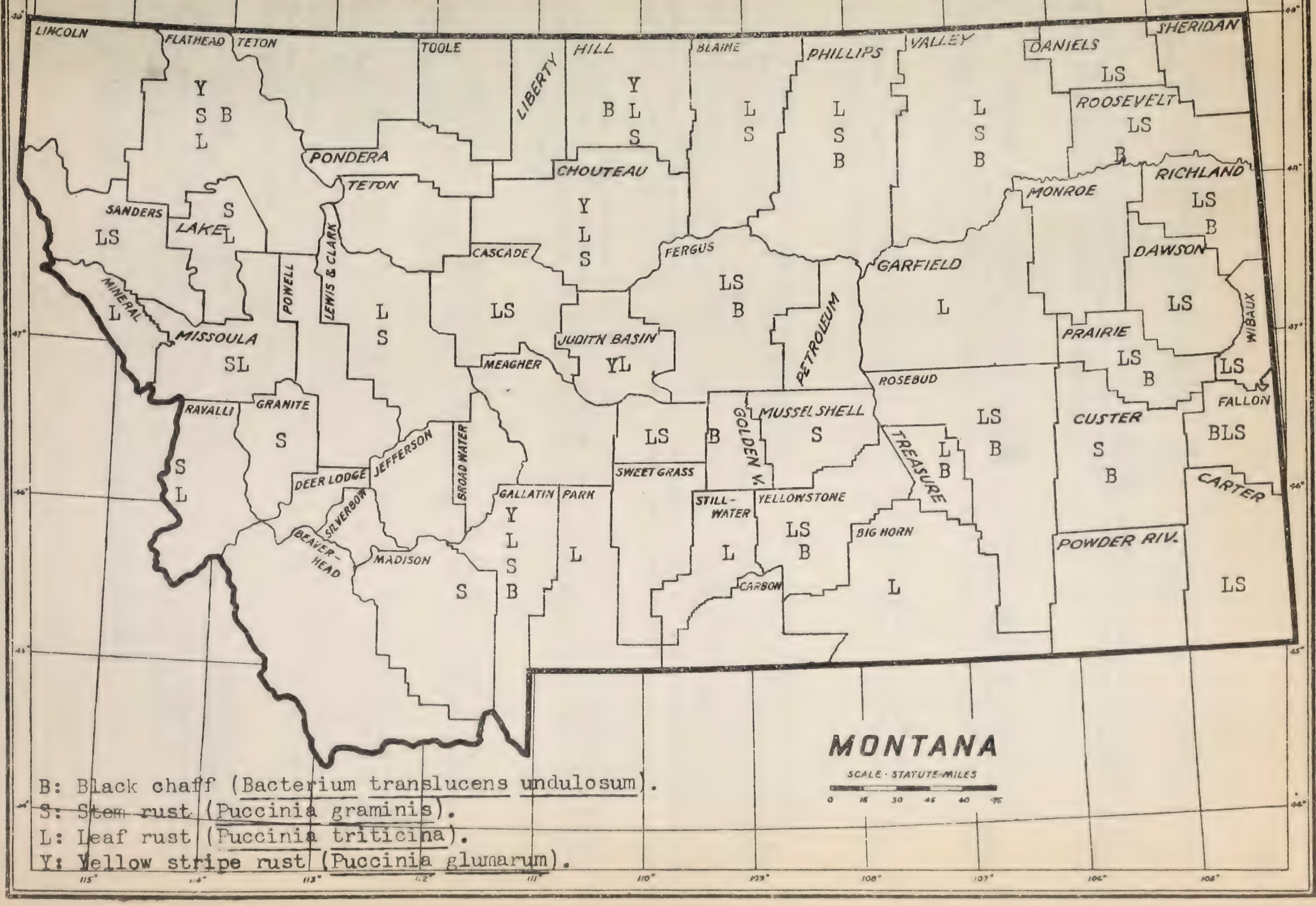
In Richland County, black chaff was severe on most of the heads of spring wheat in ten fields aggregating about 3,000 acres. The damage in this region is estimated as 12 per cent. The fields were abnormally dark colored, due to black chaff when they ripened. The grain was shrivelled.

In Prairie County, six fields of Marquis wheat aggregating 770 acres were inspected. They showed 1, 5, 10, 18, 50, and 75 per cent of the heads affected with black chaff respectively, but the damage was severe only in one field that had been sowed into stubble.

In Fergus County, the disease was common. Traces to 20 per cent of the heads were diseased in six fields of Turkey Red wheat aggregating 520 acres. The damage was probably about 1 per cent.

BASAL GLUME ROT (Phytomonas atrofaciens (MC C.) Com. S. A. B.). One collection of wheat heads from Judith Basin County was identified by Miss Lucia McCulloch as having basal glume rot. Probably the disease occurs elsewhere, but was not separated from black chaff, and the diseases caused by Septoria nodorum and Helminthosporium.

Fig. 5. Black Chaff and Rusts of Montana Wheat, 1928.



B: Black chaff (Bacterium translucens undulosum).
S: Stem rust (Puccinia graminis).
L: Leaf rust (Puccinia triticina).
Y: Yellow stripe rust (Puccinia glumarum).

GLUME BLOTCH (*Septoria nodorum* Berk.). Glume blotch was found in Fergus, Roosevelt, Richland, Garfield, Prairie, Daniels, and Hill Counties in 1928.

Two fields in Daniels and Hill Counties showed infestations of 100 per cent, but suffered little damage. Only traces to 5 per cent were seen elsewhere. Glume blotch is not serious in Montana.

SPECKLED LEAF BLOTCH (*Septoria tritici* Desm.). *Septoria tritici* was found in mild infestations in Turkey Red wheat in four fields and the Agronomy Department plots at Bozeman, Montana. Traces were found in a field of Marquis wheat in Rosebud County.

It was first reported in Montana in 1927 when a 100 per cent mild infestation occurred in two small plots of Turkey Red (Montana 36) wheat in the Agricultural Experiment Station at Bozeman.

POWDERY MILDEW (*Erysiphe graminis* DC.). Mildew was found in Gallatin, Yellowstone, Ravalli, and Petroleum Counties. It was not noticed in the northeastern part of Montana. Heavy infestations have occurred on the lower leaves and internodes of several varieties of wheat in the Agronomy Department plots at Bozeman during the last four years. In 1928, Turkey Red, Albit, Regal, Ridit, Crail Fife, Marquis, Federation, Reliance, Ceres, and Supreme wheats were affected, but little damage was done (Powers and Clark, 1929).

Mildew was abundant in a 40 acre field of Kharkof wheat at Huntley, according to A. E. Seamans, Agronomist at the Experiment Station there. Subsequent drouth caused most of the mildew to become inconspicuous, so it probably did little damage.

HEAD MOLDS (mostly *Fusicladium alopecuri* E. & E.). Head molds were common on ripening Turkey Red wheat in Fergus, Gallatin, Judith Basin, Wheatland, Yellowstone, and Big Horn Counties.

In Fergus and Judith Basin Counties, the head mold was associated with foot rot and many heads were examined microscopically. Fusicladium was abundant while Helminthosporium and Alternaria were seen too rarely to be significant. Fusicladium probably did some damage as a facultative parasite. It was seriously abundant on wheat sent from Great Falls in 1927. In this case, it was associated with shrivelled grain.

*Taxonomy*. The above determination is not definite. *Fusicladium alopecuri* has mostly one celled spores and occurs on old leaves of Alopecurus. The Fusicladium on wheat has one to three celled, sometimes echinulate spores, so it may be a new species. The spore sizes are 15-35 x 8-13 microns.

*Alternaria tenuis* Neés occurred on some wheat heads.

SCAB (*Gibberella saubinetii* (Mont.) Sacc.). Scab was found in 1928. It was determined by Dr. H. B. Humphrey. It is probably rare in Montana.

ERGOT (*Claviceps purpurea* (Fr.) Tul.). Traces of ergot in wheat were collected in Ravalli County by W. L. Jellison in 1928, and in Hill County by D. A. Savage in 1927.

SCLEROTIUM ROOT ROT (*Typhula graminum* Karst.). One farmer in Gallatin County has suffered from *Typhula graminum* heretofore called *Sclerotium rhizodes*, attacking one field of winter wheat in the spring before the heads appear. Detailed observations are planned for next spring.

CRINKLE JOINT (Nonparasitic). Small numbers of crinkle joint wheat stems were found in 1928. It occurs each year, but usually is not destructively abundant. H. L. Seamans found it in Flathead County in 1916.

The symptom is the "N" shaped (crinkled) stems usually broken (sometimes just bent or sharply curved) generally above the second nodes of the stems. The stems are bent upward in an acute angle at the nodes above the broken internodes. The unequal growth of a node in returning the top of a grass to an erect position is a common phenomenon. and readily accounts for crinkle joint of wheat on a physiological basis. Bolley (1913, Figure 12) illustrated crinkle joint.

In a special survey in 1926, crinkle joint was found in Marquis wheat in Valley, Daniels, Sheridan, and Roosevelt Counties. Heads on crinkle joint stems were often poorly filled and were so low that many are not harvested. Some fields suffered 5 to 10 per cent damage from crinkle joint, but the damage was less in most fields. It was also destructive in this region in 1927. In one field, 15 per cent of the stems were distorted by crinkle joint.

Wind is probably the chief agent that breaks the crinkle joint wheat stems. Many farmers in 1926 blamed hail for the damage, but few were able to collect hail insurance on this basis. In the most seriously injured field, one to five stems per stool had crinkle joint while the rest were normal. Maybe the second internodes were abnormally weak in these broken stems.

PHYSIOLOGICAL LEAF SPOT. A serious abnormality has been present in the plots of the Agronomy Department of the Montana Agricultural Experiment Station during the last four or more years. The leaf spots are oval to elongate, light brown and have narrow, yellow margins. Superhard, Black Hull, Ridit, and Nebraska 60 were the varieties most seriously affected. In the plots of Superhard and Black Hull varieties of wheat, 50 to 75 per cent of the leaf area was destroyed by this abnormality in 1927 and 1928. Wheat in experimental plots of the Moccasin Agricultural Experiment Station was similarly spotted. No parasites were found to be associated with this type of leaf spot. Dr. H. B. Humphrey suggested that varietal (genetic) weakness might cause such spots.

Powers and Clark (1928) report that the Superhard and Black Hull plots of wheat described above yielded more than other varieties of wheat in 1928.

These are excellent varieties to yield so well when much of the leaf area was destroyed by the physiological leaf spot.

BROWN LEAF SPOT (Undetermined). Brown leaf spots, oval to circular in outline and 1 to 2 mm. in diameter were common in fields of Turkey Red wheat in Fergus County. They were associated with Helminthosporium foot rot. Many of the spots had light brown to gray centers and dark brown margins. In one field of 40 acres, 100 per cent of the leaves and 25 to 50 per cent of the leaf area was spotted. Traces to 1 per cent of such leaf spots were found in six other fields.

MOTTLE AND CHLOROTIC STRIPE (Undetermined). Fields of Turkey Red wheat affected with foot rot in Fergus, Judith Basin and Cascade Counties exhibited two peculiar related symptoms. Many of the leaves of chlorotic plants (before heading) exhibited leaves that bore long, chlorotic stripes or mottled spots. Specimens with these symptoms were examined by Dr. A. G. Johnson and H. H. McKinney who decided that the cause of the abnormality was neither mosaic nor rosette. Foot rot and drouth probably caused these symptoms. They occurred on 1 per cent of the plants in eight fields.

LEAF GIRDLE (Nonparasitic). Seedlings of spring wheat sent to Bozeman in 1928 showed one or two white, constricted, twisted regions about 1 cm. long in each of several leaves. There were yellow borders at the ends of the injured spots. The other parts of the leaves were normally green. Wind or frost probably caused this injury. It resembles leaf girdle in barley.

BLAST (Nonparasitic). Two plots of Supreme and Pelisse wheat at the Huntley Agricultural Experiment Station showed 20 to 30 per cent of the heads partly blasted. Hot, dry winds during the booting stage may have caused this blasting.

Table 42. Estimated percentages of losses from serious diseases of wheat in Montana, 1928.

| Disease | Type of Loss | Kind of wheat | Percentage of Loss | Total Percentage Loss |
|---|---|---|---|---|
| Bunt | Dockage Loss | All Wheat | - | 0.5 |
| Bunt | Yield Loss | Spring Wheat | 0.63 | - |
| Bunt | Yield Loss | Winter Wheat | 3.6 | - |
| Bunt | Yield Loss | All Wheat | - | 1.1 |
| Loose Smut | Yield Loss | All Wheat | - | 0.1 |
| Foot Rot | Yield Loss | Winter Wheat | 10. | - |
| Foot Rot | Yield Loss | Spring Wheat | 1. | - |
| Foot Rot | Yield Loss | All Wheat | - | 2.7 |
| Red Leaf Rust | Yield Loss | All Wheat | - | 1. |
| Stem Rust | Yield Loss | All Wheat | - | 0.1 |
| Other Diseases | Yield Loss | All Wheat | - | 1. |
| Total Losses | | | - | 6.5 |

Loss figures adjusted to acreages of crops.

## OATS(Avena sativa L.)

1928: 554,000 acres; 20,221,000 bushels; $8,291,000.

SMUT (Ustilago levis (K. & S.) Magn. and U. avenae (Pers.) Jens.). Oat smuts are destructive in Montana. U. levis is the more abundant of these two, although both are widely distributed in the state and often occur in the same fields. Ustilago levis was collected in 16 counties, and U. avenae was found in seven counties (Figure 6). Most farmers do not treat their seed to control oat smuts.

Table 43 shows the results of the preliminary field survey made in 1928. An average of 5.7 per cent of the heads were smutty in 36 fields aggregating 1486 acres. Applying this percentage to the valuation of the crop in Montana calculates a loss of $472,587.

Table 43. Oat smuts. Montana, 1928.

| County | Acres | Per cent | County | Acres | Per cent |
|---|---|---|---|---|---|
| Judith Basin | 200 | 17 | Yellowstone | 91 | 14.6 |
| Wheatland | 40 | 0.25 | Stillwater | 42 | 0.38 |
| Chouteau | 50 | 10. | Garfield | 60 | 0.17 |
| Valley | 170 | 0.97 | Prairie | 60 | 0.66 |
| Roosevelt | 40 | 8 | Fallon | 60 | 0.25 |
| Daniels | 200 | 7 | Powell | 78 | 0.51 |
| Blaine | 35 | 25 | Gallatin | 35 | 3 |
| Rosebud | 210 | 0.8 | Ravalli | 40 | 0.75 |
| Big Horn | 60 | 0.17 | Deer Lodge | 15 | 0 |

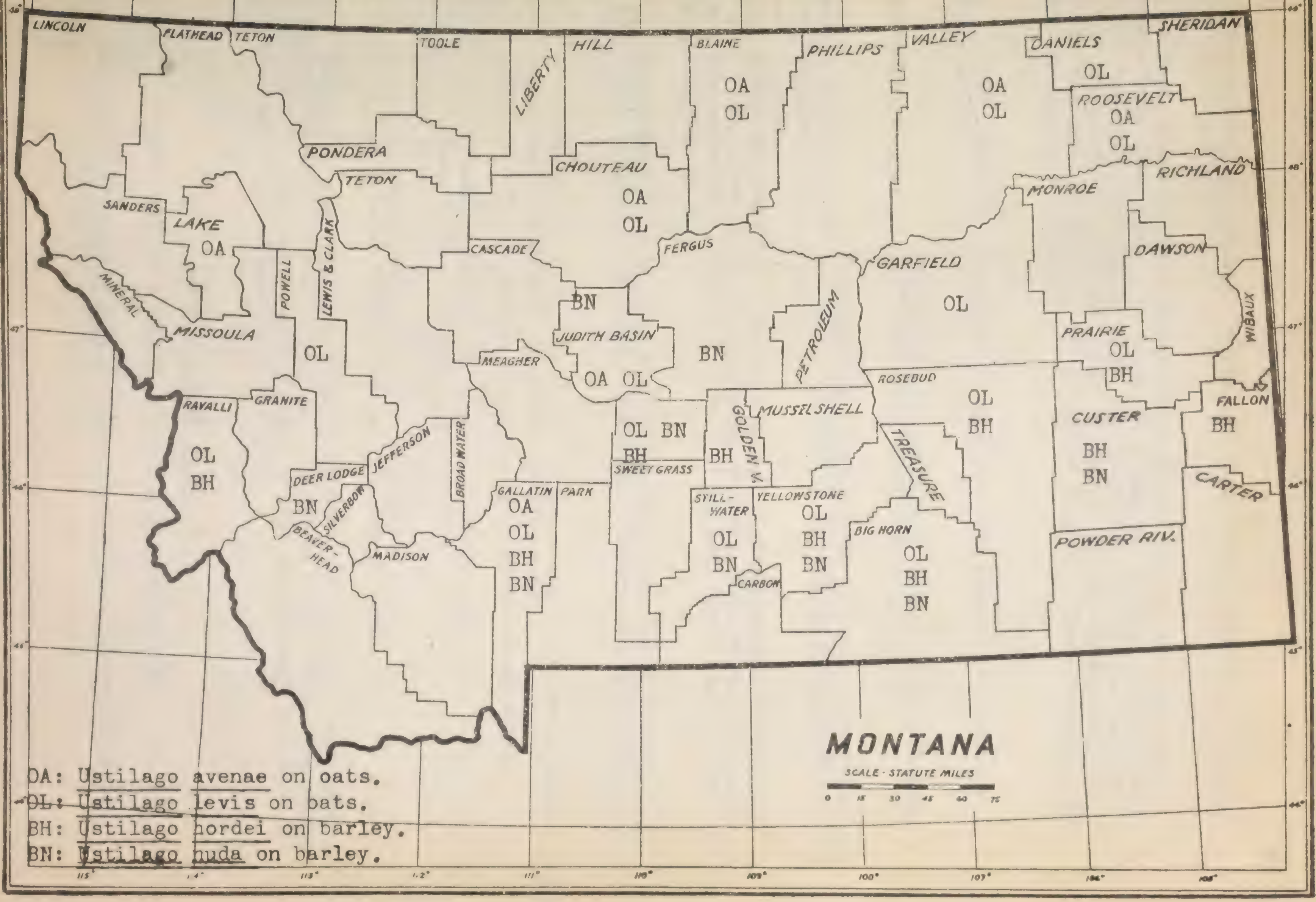
Totals: 1,486 acres; acreage-percentage product is 84.41; average percentage for the 18 counties is 5.7 per cent. Calculations like those in Table 40.

STEM RUST (Puccinia graminis Pers.) of Oats. Traces of black stem rust were found in cultivated oats in Yellowstone, Valley and Roosevelt Counties. A 100 per cent infestation on Avena fatua was found in Valley County. Traces were also found on wild oats in Blaine County. Arthur reported it on wild oats (N. A. F. 7: 296). Puccinia graminis usually does little damage in cultivated oats in Montana. (Table 38).

CROWN RUST (Puccinia coronata Cda). Dr. H. B. Humphrey found a serious amount of crown rust in one field in Sheridan County. W. L. Jellison found traces of crown rust on oat panicles in Flathead County. It usually is not destructive in Montana and is rarely seen.

HALO BLIGHT (Phytomonas coronafaciens (Elliott) Com. S. A. B.). Traces of halo blight were found in Swedish Select oats in Judith Basin County (Experiment Station at Moccasin), and on Green Russian (C. I. 2344) oats in an

Fig. 6. Smuts of Oats and Barley in Montana, 1928.



OA: Ustilago avenae on oats.
OL: Ustilago levis on oats.
BH: Ustilago hordei on barley.
BN: Ustilago nuda on barley.

experimental plot at Bozeman. In 1928, H. M. Jennison collected it in Stillwater and Park Counties.

Under some conditions typical halos do not occur on the leaf spots. Elongate brown leaf spots, 1 to 10 cm. long, that had no halos, but sometimes had red margins, occurred in Montana. They destroyed half the leaf area of 10 per cent of the leaves in an 80 acre field of oats in Rosebud County. Smaller amounts were found in Gallatin and Stillwater Counties. These bacterial leaf spots were possibly halo blight.

OTHER PARASITES. *Macrosporium avenae Oud.* was found on oat leaves at Bozeman in 1925.

*Colletotrichum graminicolum* (Ces.) Wils., anthracnose. Collected at Bozeman in 1918. Apparently first record for state.

*Heterosporium phragmitis* (Opiz.?) Sacc. occurred on oat leaves in Prairie County in 1928. It resembles *Fusicladium destruens* Pk. except in echinulation of its spores.

BLAST (Nonparasitic). This abnormality is very destructive throughout the state. It did about 10 per cent damage in 1928. Inspections revealed it in nine widely separated counties this year. It was more severe than in 1927, and less severe than in 1926.

Percentages found in field inspections are exemplified by fractions such as 1-3/10 which means 1 to 3 sterile spikelets on 10 per cent of the stems in the field.

Rosebund County: 230 acres, 1-3/10 per cent; 30 acres, 5/90 per cent.
Garfield County: 40 acres, 1-5/80 per cent.
Yellowstone County: 40 acres, 1-5/75 per cent; 100 acres,
3/50; 10 acres, 1-8/100.
Wheatland County: 15 acres, 1-5/100 per cent.
Park County: 10 acres, 2/100 per cent.
Prairie County: 20 acres, 5/90 per cent.
Missoula County: 20 acres, 3-5/100 per cent.
Stillwater County: 2 acres, 1-10/100 per cent.

Since cultivated oats bear about 75 spikelets per panicle, the inspection percentages indicate a loss of about 5 per cent due to blast. These inspections did not cover the main region of production of oats in northeastern Montana in which the damage was estimated as 10 per cent.

## BARLEY (*Hordeum vulgare* L.)

1928: 209,000 acres; 6,374,000 bushels; $3,569,000.

COVERED SMUT (*Ustilago hordei* (Pers.) Kell. & Sw.). Covered smut was found in the counties shown in Figure 5.

Table 44 based on inspections of 24 fields showed an average of 2.8 per cent of covered smut in 626 acres. Covered smut regularly does serious damage to barley in Montana.

LOOSE SMUT (*Ustilago nuda* (Jens.) Kell. and Sw.). Loose smut of barley is serious in Montana. It was found in the counties shown in Figure 6. Table 45 based on inspections of 16 fields, showed an average of 3.4 per cent loose smut in 465 acres.

Table 44. *Ustilago hordei* in barley in Montana. 1928*.

| (1) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|
| County | Acres | Per cent | Acres x per cent | Average Per cent |
| Gallatin | 20 | 0 | | |
| Yellowstone | 121 | 0-10 | 3.56 | (3) |
| Wheatland | 135 | 0-2 | 2.30 | (1.7) |
| Golden Valley | 20 | 1 | .20 | |
| Garfield | 5 | 0 | | |
| Prairie | 40 | 0.25-9 | 1.85 | (4.6) |
| Fallon | 160 | 0-3 | 2.65 | (1.7) |
| Treasure | 40 | 0.25 | .1 | |
| Rosebud | 15 | 25 | 3.75 | |
| Custer | 50 | 5 | 2.50 | |
| Ravalli | 20 | 3 | .60 | |
| Totals | 626 | | 17.42 | 2.8 |

*Calculations like those in Table 40.

Table 45. Ustilago nuda in barley in Montana. 1928*.

| (1) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|
| County | Acres | Per cent | Acres x per cent | Average Per cent |
| Yellowstone | 90 | | .53 | (.58) |
| Stillwater | 10 | 2 | .20 | |
| Fergus | 40 | 1 | .40 | |
| Big Horn | 230 | | 8.83 | (3.84) |
| Gallatin | 70 | | 5.70 | (8.14) |
| Deer Lodge | 25 | | .15 | (0.4) |
| Totals | 465 | | 15.81 | (3.4) |

*Calculations like those in Table 40.

STEM RUST (*Puccinia graminis* Pers.). Traces of black stem rust of barley were found in Fallon, Richland, and Flathead Counties,(Table 38).

STRIPE RUST (Puccinia glumarum (Schm.) Eriks.). Traces were seen on beardless cultivated barley and Hordeum jubatum in Flathead County.

STRIPE (Helminthosporium gramineum Rabh.). Barley stripe destroyed 13 per cent of the leaf area in 70 acres of barley in Richland County. It was abundant in a 6 acre field in Stillwater County. It destroyed 30 per cent of the leaf area in a 40 acre field in Ravalli County. It also occurred in Gallatin, Judith Basin and Dawson Counties. It was destructive in an experimental plot of Hannchen barley at Bozeman in 1926. While barley stripe is common, its annual damage is small.

FOOT ROT (Helminthosporium sativum Pam., King, and Bakke.). Foot rot of barley is probably more serious than records show. A 10 acre field of barley in Lake County had 10 per cent of the plants injured by foot rot.

LEAF SPOT (Hormodendron hordei Bruhne). This fungus destroyed 20 per cent of the leaf area on all the stems in a 5 acre field of barley in Yellowstone County. It was identified by Dr. Charles Drechsler. It is probably common in central Montana.

LEAF SPOTS (due to Helminthosporium teres, H. gramineum and H. sativum, Hormodendron, et al.). Leaf spots, with causes not definitely determined, were abundant in Big Horn and Wheatland Counties. Traces were seen in Stillwater and other counties.

LEAF GIRDLE (Nonparasitic). Specimens of barley seedlings collected in Glacier County in 1927 showed peculiar symptoms. Some leaves showed white, shrivelled, twisted regions 1 cm. long, with green or brown tissues in the rest of the leaves between the injuries and the tips. Wind or frost probably caused these injuries. These symptoms are like those of leaf girdle in wheat.

OTHER PARASITES OF CULTIVATED BARLEY. Bacterium translucens Jones, Johnson and Reddy. (U. S. Bulletin 1366); Claviceps purpurea (Fr.) Tul. Hill County, 1927; Helminthosporium teres Sacc. Gallatin County in 1916, Puccinia simplex Pk. Stillwater County.

## RYE (Secale cereale L.)

1928: 154,000 acres; 2,156,000 bushels; $1,488,000.

One hundred and eighty acres of rye in nine fields in Custer, Rosebud, Yellowstone, and Treasure Counties showed no diseases.

LEAF RUST (Puccinia dispersa Eriks.). Traces of leaf rust were found on rye at Bozeman.

ERGOT (Claviceps purpurea (Fr.) Tul.). Traces of rye ergot were found in Ravalli and Flathead Counties. It was found in Richland County in 1924, and in Hill County in 1927.

CRINKLE-JOINT (Nonparasitic). Traces of crinkle joint were seen in rye in Park County.

## CRESTED WHEAT GRASS (Agropyron cristatum J. Gaert.)

Traces of Claviceps purpurea (Fr.) Tul. occurred in Hill County in the Agronomy Plots, according to D. A. Savage, Agronomist.

## FIELD CORN (Zea mays L.)

SMUT (Ustilago zeae (Beckm.) Ung.). Traces were found in Gallatin, Yellowstone, and Ravalli Counties. At Huntley in 1927, 3 per cent of the corn in two plots was smutty.

PURPLE SHEATH SPOT (various facultative parasites). Traces were found at the Experiment Station at Huntley in 1927 and 1928. Microscopical examination revealed no Physoderma.

BLACK BUNDLE DISEASE (Cephalosporium acremonium Cda.). Typical symptoms were found in a stalk of corn in a plot at the Huntley Experiment Station in 1927. It was not seen there in 1928.

## SWEET CORN (Zea mays rugosa Bonaf.)

BLACK BUNDLE DISEASE (Cephalosporium acremonium Cda.). Black bundles occurred in about 1 per cent of the stems in two fields in Yellowstone and Flathead Counties. In Missoula County, 15 per cent of the stalks in a 1 acre field had typical black bundles. It was not found at Bozeman.

## SORGHUM (Holcus sorghum L.).

**LEAF** SPOT (Bacterium holci Kendrick). Traces occurred in 90 per cent of the leaves in a half acre plot in the experimental plots at Huntley (Yellowstone County).

TRANSLUCENT BACTERIAL STRIPE (Unnamed). This disease was identified by Dr. Charlotte Elliott. She has submitted a preliminary description of it for publication; (Elliott, 1929). It was found in Yellowstone and Dawson Counties.

COVERED SMUT (Sphacelotheca sorghi (Lk.) Clint.). First reported from Carbon County in 1912, and in Flathead County about 1916.

BLAST (Nonparasitic). Traces were seen in Yellowstone County.

## SUDAN GRASS (Holcus sudanensis Bailey).

LEAF SPOT (Bacterium holci Kendrick). This disease destroyed half the leaf area in 0.5 acre of plots at Huntley (Yellowstone County).

## MILLET (Setaria italica Beauv.)

DOWNY MILDEW (Sclerospora graminicola (Sacc.) Schroet.). This disease was first found in Montana in 1928 when it was collected in Big Horn, Garfield, Prairie, Fallon, and Carter Counties. It was also collected at Devil's Tower, Wyoming, and at Gustave, South Dakota (Southwest corner of state). The identifications were checked by Dr. W. H. Weston, Jr.

Only the leaf spot stage of the disease was found. Conidiophores and spores were abundant. It occurred as traces on 1 to 20 per cent of the plants in seven fields aggregating 70 acres. It was not destructive, but was interesting as a new disease in Montana.

Sclerospora graminicola was abundant on Setaria viridis in Stillwater, Yellowstone, Treasure, Rosebud, Fallon and Custer Counties. It was also found at Sundance, Wyoming, and at Gustave, South Dakota. Usually, only spore-bearing leaf spots were found, but in Yellowstone County, several collections were made of shredded leaves containing oospores. The identification was checked by Dr. W. H. Weston, Jr. and Dr. H. R. Rosen.

LEAF SPOT (Pseudomonas alboprecipitans Rosen). All the fields of millet seen showed a common bacterial leaf spot. Dr. Charlotte Elliott identified the cause of Pseudomonas alboprecipitans in specimens ~~as~~ millet collected in Prairie and Fallon Counties. The spots were mixed with leaf spots caused by Sclerospora. Similar bacterial leaf spots, supposedly due to the same cause, were found in Garfield, Big Horn, and Carter Counties.

## TIMOTHY (Phleum pratense L.)

STEM RUST (Puccinia graminis Pers.). Timothy rust was abundant in the Agronomy Department at Bozeman, and occurred in Yellowstone, Missoula, and Flathead Counties. W. L. Jellison and James Bradbury found it affecting 10 to

100 per cent of the stems in six fields of timothy in Ravalli County. It was found in Stillwater County in 1918.

SMUT (Ustilago striaeformis (West) Niessl.). D. B. Swingle found timothy smut at Bozeman in 1914.

## QUACK AND WHEAT GRASSES (Agropyron spp.)

Claviceps purpurea (Fr.) Tul. Common. Hill and Yellowstone Counties.
Erysiphe graminis DC. (United States Bulletin 1366).
Puccinia agropyri E. & E. (Jones, 1910; N.A.F. 7:335).
P. graminis Pers. (N.A.F. 7: 296).
P. montanensis Ellis (N.A.F. 7:331).
P. obliterata. Arth. Yellowstohe County.
P. pattersoniana Arth. (N.A.F. 7:330).
P. rubigo-vera (DC.) Wint. (Anderson, 1889).
Ustilago hypodytes (Schl.) Fr. Billings, 1900 (Griffiths, West American Fungi No. 201.)

## VEGETABLE CROPS

### BEAN (Phaseolus vulgaris humilis Alef. and spp.)

1928: 43,000 acres; 624,000 bushels; $2,402,000.

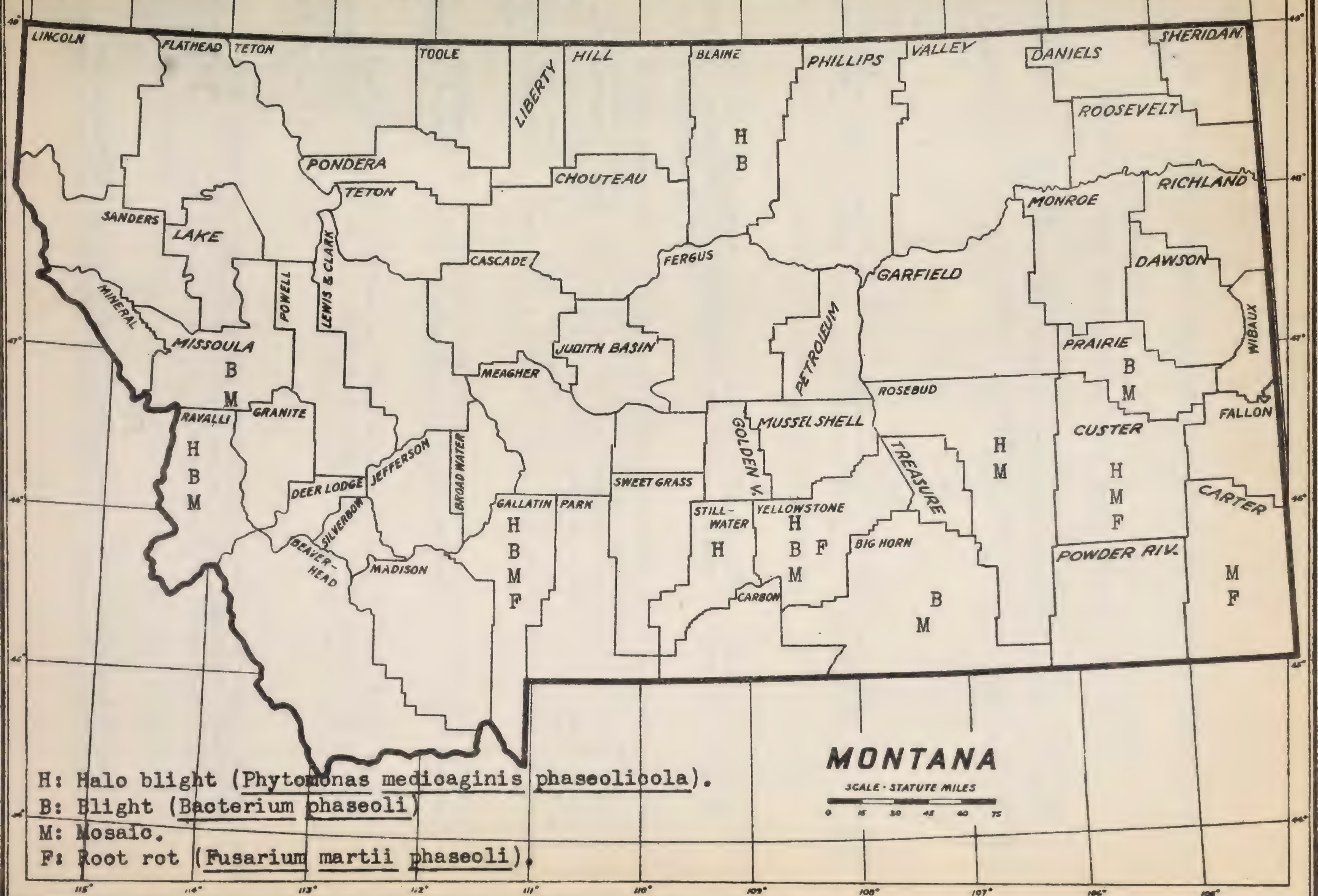
HALO BLIGHT (Phytomonas medicaginis phaseolicola Burkholder). Halo blight was found to be destructive in garden and canning varieties of beans at Huntley (Yellowstone County) in 1927. This was the first record of its occurrence in destructive form in Montana. Isolations made by Professor D. B. Swingle in 1926 did not reveal it at Bozeman. Figure 7 gives its known distribution in 1928. It has not been definitely identified yet in Great Northern beans.

Halo blight threatens to become more serious in canning beans such as Golden Wax, Black Wax, and Burpee's Stringless Green Pod.

Table 46 shows the estimated percentages of leaf area destroyed. Such reduction is not directly correlated with reduction in yields, which is less than the calculated percentages. However, the actual loss is increased by the spotted pods, discolored seeds, and girdled stems. Attacks upon young bean plants are often fatal.

A correlation between halo blight and inoculation of beans with Bacillus radicicola was established by Dr. Wilbur Brotherton at Bozeman. He inoculated with Bacillus radicicola the Burpee's Stringless Green Pod beans, in a one-acre field, and did not inoculate the beans of this variety in an adjacent, three-acre field. Halo blight was much more abundant in the field with the inoculated

Fig. 7. Bean Diseases in Montana, 1928.



H: Halo blight (*Phytomonas medicaginis phaseolicola*).
B: Blight (*Bacterium phaseoli*)
M: Mosaic.
F: Root rot (*Fusarium martii phaseoli*).

seed.

Dr. Brotherton reduced the spread of halo blight in the field by severe roguing.

Table 46. Halo blight of canning beans. Montana, 1928*.

| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|
| County | No. of Fields | Acres | Per cent | Acres x per cent | Weighted percentage | Per cent | Per cent x Column 5 | Weighted percentage |
| Yellowstone | 4 | 27 | | 6.85 | (25) | | .8955 | (3.3) |
| Gallatin | 15 | 100 | | 15.15 | (15) | | 3.6750 | (3.7) |
| Blaine | 5 | 15 | | 11.01 | (73) | | 3.3001 | (22) |
| Custer | 3 | 11 | | 6.45 | (59) | | 2.1500 | (20) |
| Rosebud | 1 | 20 | 75 | 15.00 | (75) | 5 | .7500 | (3.75) |
| Stillwater | 1 | 1 | 30 | .30 | (30) | 25 | .075 | (7.5) |
| 6 counties | 29 | 174 | | 54.76 | (31.5) | | 10.8456 | 6.2 |

*Calculations like those in Table 40.

BLIGHT (Phytomonas phaseoli (E.F.S.) Com. S.A.B.). Blight is common and sometimes destructive in Great Northern beans. Figure 7 shows the counties where it was found in 1928.

It was found in 11 fields aggregating 240 acres of Great Northern beans in Yellowstone County. In most fields there were traces to 15 per cent of the plants affected, with only slight visible damages. The loss was about 2 per cent in four fields, in one of which each plant bore one to five leaf spots. Only slight damage from light infestations was found in Missoula, Gallatin and Prairie Counties. There was a loss of 5 per cent in a 30 acre field in Big Horn County.

Professor D. B. Swingle made many isolations of bacteria from blighted beans at Bozeman in 1926. Phytomonas phaseoli predominated in his cultures.

BACTERIAL WILT (Phytomonas flaccumfaciens (Hedges) Com. S.A.B.). This parasite was identified by Miss Florence Hedges in Great Northern bean seed grown at Billings (Yellowstone County) in 1927. She reported it in seed from Montana in (1925) 1926.

RUST (Uromyces appendiculatus (Pers.) Lk.). Bean rust was found as a mild infestation in 5 acres of Great Northern beans at the Experiment Station at Huntley (Yellowstone County) in 1927. It was not seen in the same field nor elsewhere in 1928.

ANTHRACNOSE (Colletotrichum lindemuthianum (Sacc. & Magn.) Briosi & Cav.). Anthracnose has been introduced occasionally into Montana in infected seed but apparently has not overwintered or spread here seriously.

Anthracnose was abundant in gardens at Bozeman in 1912 as a result of planting diseased seed but has not been reported since. Professor D. B. Swingle identified it then in his garden and furnishes this information.

MOLD (Cladosporium herbarum phaseoli). This fungus was tentatively identified on bean leaves from Gallatin County by Dr. L. L. Harter.

ROOT ROT (Fusarium martii phaseoli Burk.). Figure 7 shows the counties where root rot was found in 1928. Field inspections of 14 fields aggregating 120 acres showed infestations of 1 to 5 per cent. It was not seen in the other bean fields considered in Tables 46 and 47.

ROOT NODULES (Rhizobium leguminosarum Frank). Root nodules occur on beans in Gallatin County. These are general in distribution, but rarely reported.

Root nodules or tumors caused by R. leguminosarum (Bacillus radicicola) represent diseases like the diseases caused by Phytomonas tumefaciens and Caconema radicicola. The essential difference is that R. leguminosarum usually benefits its hosts more than it injures them. Palladin and Livingston (1918) state that late season infections may be injurious because the bacteria are parasitic.

MOSAIC (Virus). Bean mosaic is abundant and destructive in Montana (Figure 7). It will probably continue to be serious. Dr. T. G. Fajardo in Wisconsin separated the primary (current season) and secondary (typical) symptoms of bean mosaic. The early canning and garden beans in Montana usually show only primary symptoms which are general chlorosis and prominent rugosity with yellow tops on the rugose blisters. Often mosaic in this form does not reduce the yield greatly, although the secondary (typical) form decreases the yield very much when the symptoms are severe. Great Northern beans exhibit both primary and secondary symptoms of mosaic. Vascular streaking (hypophyllous) was associated with mosaic.

Table 47 shows the result of field inspections. Many of the percentages of prevalence were too low because about half of the inspections were made before the maximum number of plants shows symptoms. Mosaic attracted most attention by its abundance after August 15, 1928.

In 1917, 100 acres of Great Northern beans contained 2 per cent mosaic.

Table 47. Bean mosaic. Montana, 1928*.

| (1) | (2) | (3) | (5) | (6) |
|---|---|---|---|---|
| County | No. of Fields | Acres | Acres x Per cent | Average Per cent |
| Yellowstone | 56 | 942.6 | 40.85 | (4.3) |
| Big Horn | 6 | 110 | 3.05 | (2.7) |
| Rosebud | 4 | 92 | .14 | (.15) |
| Custer | 3 | 11 | .35 | (3.2) |
| Prairie | 2 | 50 | .75 | (1.5) |
| Carter | 1 | 2 | .01 | 0.5 |
| Gallatin | 5 | 11.05 | 1.95 | (17.7) |
| Ravalli | 1 | 1 | .05 | (5) |
| Missoula | 2 | 10.13 | .5 | (5) |
| Totals | 81 | 1,229.8 | 47.66 | 3.9 |

*Calculations like those in Table 40.

CALICO (Undetermined). Many Great Northern beans in Yellowstone County showed prominent yellow blotches in the leaves that suggested calico in potatoes. The symptoms were associated with mosaic.

PSEUDOMOSAIC (Genetic). Prominent symptoms of this abnormality occurred in two crosses of hybrid beans (Rogers' Stringless Refugee X Davis White Wax) made by Dr. Wilbur Brotherton. The 4th and 6th generations were grown in 1928. Burkholder and Muller (1926) described this abnormality.

## DWARF LIMA BEAN (Phaseolus limensis limenanus Bailey).

BLIGHT (Phytomonas phaseoli (E.F.S.) Com. S.A.B.). Blight caused a serious spotting of lima bean pods at the Experiment Station at Huntley (Yellowstone County).

## PEAS (Pisum sativum L.)

Seed peas (1928: 19,000 acres; 332,000 bushels; $664,000.
Canning peas (1928: 3,500 acres; 3,800 tons; $209,000.

Most of the information concerning pea diseases in Montana in 1928 is drawn by permission from a report prepared by Dr. M. B. Linford, Associate Pathologist, United States Department of Agriculture, following a special survey of pea diseases which he made for the Office of Vegetable and Forage Diseases, Bureau of Plant Industry. He inspected 57 fields in Gallatin, Park, and Carbon Counties. (Linford, 1929).

BACTERIAL BLIGHT (Phytomonas pisi (Sack.) Com. S.A.B.). This disease has been common in Montana since 1916. It occurred in epidemic form in 1918 causing a 25 per cent reduction in yield. In 1927, it was found in Yellowstone County and did serious damage in Gallatin County. Near Manhattan, in 85 acres of peas in five fields of different varieties, there was an average of 53 per cent of the plants diseased, 36 per cent were damaged causing a loss of 8 per cent in yield.

It was found in Gallatin, Park, Stillwater, Judith Basin and Carbon Counties in 1928. Dr. Linford found it in 9 of the 57 fields which he examined. Reduction in yield was slight, but there was considerable seed infection.

Evidence indicates that serious infestations and losses are associated with foliage injury caused by hail, wind-blown rain, or wind-blown sand which furnishes infection courts. The character of the season is an important factor in the occurrence and destructiveness of this disease and for this reason it may be expected to occur sporadically.

ROOT ROT (Aphanomyces euteiches Drechs.). Root rot was abundant and destructive in 1928. Dr. Linford found it in 30 of the 57 fields that he inspected. In 80 per cent of these infested fields, more than half of the plants were infected. The effects were variable, however, for some infestations of 100 per cent caused only small reductions in yield, while others practically caused crop failure.

Aphanomyces root rot was first found in Montana in 1921 by Dr. F. R. Jones who detected it in Park County. In 1928, it did great damage in Park County where 7 of the 8 fields examined were heavily infested. One extensive grower of peas stated that the yield of peas had decreased more than 50 per cent in the last ten years in this county, until now growers sometimes fail to get even their seed back. Root rot appears to have been the main factor in this decline.

In Gallatin County root rot was found in 19 of the 39 fields inspected, although Dr. F. R. Jones could find scarcely any of it here in 1921 and 1923. Pea fields that had not produced peas before 1928 seldom contained this disease, but most of those that had produced two or more crops during recent years were heavily infested. Apparently, soil infestation with Aphanomyces increases rapidly.

Root rot was present but not yet serious at Bridger (Carbon County) where peas have been grown during only a few years. Fields around Red Lodge and Roberts in this county were severely infested.

In Gallatin and Carbon Counties, root rot was closely correlated with continuous cropping. In one field, the fourth successive crop of peas was a failure mainly due to root rot, showing a very rapid increase in soil infestation. Growers misinterpret losses from root rot as due to over-irrigation for the initial severe development of root rot seems to occur promptly after the first irrigation. Weeds often outgrow peas, particularly peas weakened by disease.

DOWNY MILDEW (*Peronospora viciae* (Berk.) Deby.). Downy mildew was found in Gallatin, Park and Carbon Counties, affecting 11 of the 58 fields inspected. Dr. Linford found it in 10 of the 57 fields that he inspected. One infestation of 100 per cent in a 25 acre field was found in Gallatin County. The leaf spots were not abundant on the plants so the damage was not great.

MYCOSPHAERELLA BLIGHT (*Mycosphaerella pinodes* (B. & B.) Stone). Dr. Linford found this blight in 3 fields in Carbon County. It caused only slight loss, although two fields contained foci of heavy infestation. Since these fields were planted from local seed, the disease evidently perpetuates itself here and may possibly become more abundant and widely distributed.

ASCOCHYTA LEAF AND POD SPOT (*Ascochyta pisi* Lib.). Linford and Sprague (1927) separated this disease from the one caused by Mycosphaerella. Dr. Linford and the authors found it in four fields of seed peas in Park County and one field in Carbon County. It was serious on the pods in two fields, but only traces occurred in the other fields. It was first reported in Montana in 1918.

LEAF SPOT (*Ascochyta pinodella* L. K. Jones). Dr. Linford reported this disease in four fields in Gallatin County and one in Park County. Jones (1927) describes this disease.

LEAF BLOTCH (*Septoria pisi* West). Leaf blotch is common in pea fields in Montana and has been observed at Bozeman since about 1918. Dr. Linford found it in 27 of the 57 fields he inspected. It was destructive in one field in Carbon County and caused serious leaf injury in old pea fields in both Gallatin and Park Counties.

BLACK LEAF (*Fusicladium pisicola* Linford). Dr. Linford found traces of this disease in one field in Gallatin County and one in Carbon County. No former observations of it have been reported from Montana.

FUSARIUM WILT (*Fusarium orthoceras var. Pisi* Linford). Dr. Linford found this disease in Montana for the first time in 1928 in three fields in Gallatin County. He isolated and identified the causal organism. One field of Alaska peas was extensively spotted. Five acres of a large field of Perfection peas were destroyed by wilt. This field had previously grown some crops of peas. This is a very destructive disease and demands close watching.

FOOT ROTS (*Ascochyta pinodella* L. K. Jones, *Fusarium martii pisi* F. R. Jones, and other fungi). Since these diseases do not have practically distinguishable symptoms, Dr. Linford considers them together, reporting them from three fields in Gallatin County. They probably occurred elsewhere but were not distinguished from Aphanomyces root rot. It damaged most of the plants in one field without producing very conspicuous aerial symptoms. Few, if any peas had grown previously in this field.

STEM CANKER (Rhizoctonia). This disease was serious in several pea fields in Gallatin County in 1927 and was also seen in Yellowstone County. Near Manhattan, three fields aggregating 45 acres had 92 per cent of the stems badly cankered with a loss of 50 per cent. Another field on higher ground had only 1 per cent of the stems cankered. The species of the causal fungus should be identified.

Dr. Linford in 1928 reported that Rhizoctonia reduced the stand in one field in Gallatin County and occurred on 10 per cent of the plants in one field in Carbon County. He found Rhizoctonia hyphae many times in examining pea roots for oospores of Aphanomyces occurring on and in the decaying roots.

MOSAIC (Virus). Mosaic of field peas has occurred in Gallatin County for more than four years. In 1928, traces of it were found in Gallatin, Carbon and Yellowstone Counties. One variety in the experimental plots at Bozeman has shown 75 to 100 per cent of mosaic during the last two years. It was too mild to be serious, however.

INTUMESCENCES (Water relations). Dr. Linford found traces of this abnormality in one field of Alaska peas in Gallatin County. Some green pods bore succulent, elongate outgrowths.

OTHER PARASITES.

Erysiphe polygoni DC. Found by Dr. H. M. Jennison in Bozeman in 1913.

Pythium spp. (United States Bulletin 1366).

Rhizobium leguminosarum Frank, (Bacillus radicicola Beij.) causing legume tubercules. Dr. Wilbur Brotherton found these tubercules in field peas in Park, Gallatin, Madison, Jefferson, Powell, and Ravalli Counties during the last five years. Their occurrence is probably coextensive with that of pea culture in this state.

## POTATO (Solanum tuberosum L.)

1928: 37,000 acres; 4,255,000 bushels; $2,340,000.

EARLY BLIGHT (Alternaria solani (E. & M.) J. & G.). In 1927, early blight did serious damage in Yellowstone County. Alternaria attacked five rotation plots of 0.25 acres each, of Triumph potatoes on the Huntley Agricultural Experiment Station about August 1, 1927. By September 19, three plots were dead and half the leaf area on the other two plots was destroyed. Early blight reduced the yields of these plots 50 to 75 per cent.

A vine or two in each plot had symptoms of giant hill. Such vines were only slightly spotted by Alternaria while the other vines were badly diseased or dead, so these resistant vines were saved for seed and increased. They deviate from normal only slightly in agronomic characters, so their resistance to early blight will be tested further in 1929.

Early blight damaged four fields of potatoes near Billings in 1927. It was controlled by Bordeaux mixture in Carbon County in 1917.

In 1928, early blight was found in Yellowstone, Stillwater, Big Horn, Dawson, Blaine and Flathead Counties. Five rotation plots (0.25 acres each) of Triumph potatoes on the Huntley Agricultural Experiment Station were less severely damaged than in 1927, although all the vines were spotted. Alternaria destroyed 30, 90, 15, 10 and 15 per cent of the leaf area in the five plots respectively by September 1, 1928 being worst in the continuous cropping plot that it prematurely killed in 1927. These plots were not sprayed for early blight in 1927 or 1928. According to Professor C. C. Starring, Horticulturist of Montana State College, it reduced the yield 15 per cent in 2 acres of potatoes at Billings. It did similar damage to 20 acres of potatoes in Big Horn County and spread rapidly in four other fields.

Early blight is becoming serious in Montana so that growers will soon need to begin to spray to control it.

SCAB (Actinomyces scabies (Thax.) Gues.). Potato scab is common and destructive throughout Montana. (See Wilcox (1899) and Foster (1896).

RHIZOCTONIA (Corticium vagum Berk. & Curt.). Rhizoctonia is common and destructive to potatoes in Montana. In 1928, it was found in Ravalli, Missoula, Wheatland, Gallatin, Stillwater and Yellowstone Counties. Most of the infestations were not serious.

The white mold, Corticium was seen on the bases of potato stems in Gallatin and Stillwater Counties. Large sclerotia occur in Montana. The largest one seen was 2.5 x 2 x 0.5 cm.

An unusual development of aerial tubers occurred in 1916. Aerial tubers were unusually numerous and abundant on affected plants. They resembled bunches of grapes on the potato stems which bore from 50 to 200 aerial tubers each. Dr. H. M. Jennison decided that Rhizoctonia was the chief cause. It was serious in 1911 and 1912.

WILT (Fusarium oxysporum Schlecht.). Fusarium wilt causes an estimated annual loss of about 4 per cent in Montana potatoes. It is troublesome in light soils where the soil temperature is comparatively high and moisture content is low. This was described by Morris (1926).

STORAGE ROTS (Fusarium spp). Storage rots are common and destructive in Montana; they were described by Morris (1926). A serious epidemic of dry rot occurred in 1928. One grower in Gallatin County lost 15 per cent of a car of certified Irish Cobbler potatoes.

Species of Fusarium found in potato tubers in Montana by Morris and Nutting (1923):

*Fusarium trichothecioides* Woll., *F. subulatum brevius* Sherb., *F. subpallidum roseum* Sherb., *F. discolor* Ap. & Woll., *F. gibbosum* Ap. & Woll., *F. oxysporum-asclerotium* Sherb., *F. clavatum* Sherb., *F. solani* (Mart.) A. & W., *F. discolor-sulphureum* (Schl.) A. & W., *F. coeruleum* (Lib.) Sacc., *F. sclerotioides-brevius* Sherb., *F. arthrosporioides* Sherb., *F. anguioides* Sherb., *F. bullatum* Sherb., and *F. culmorum* (Sm.) Sacc.

LEAK (*Pythium debaryanum* Hesse). Present in Montana (United States Bulletin 1366).

BLACK LEG (*Erwinia atroseptica* (Van Hall) Com. S.A.B.). The history of the black leg disease of potato in Montana is very interesting. It was introduced about 1912, presumably in potato seed imported from the East. In the Twenty-third Annual Report (1916) of the Montana Experiment Station this statement appears "The diseases of the potato most important in Montana are wilt and dry rot. Black leg is rapidly spreading and is likely to be equally important if not checked." A year later (Twenty-fourth Annual Report) it is stated "The bacterial disease of potatoes known as black leg is increasing in this state to an alarming extent. We believe it is not an overstatement to say that since the introduction of the disease into Montana, it has doubled in prevalence every year. Black leg, therefore, will be given special attention next year."

A campaign of publicity was conducted regarding the nature and control of black leg which resulted in some control measure becoming adopted; consequently this disease, while present, has never been very destructive. It varies in severity from year to year. The average loss from black leg is estimated at 2 per cent.

Swingle (1917 and 1918) described its spread in the state. The following are some records of its occurrence in 1928:

| | | |
|---|---|---|
| Gallatin County | 0.1 acres | 4 Per cent |
| Ravalli County | 6 acres | 1 Per cent |
| Sweet Grass County | 2 acres | 12 Per cent |
| Wheatland County | 5 acres | 11 Per cent |
| Yellowstone County | 8 acres | 1 Per cent |

Black leg overwinters in diseased tubers. While the seed corn maggot (*Hylemyia cilicrura* Rond.) has been collected in Yellowstone, Fallon, and Big Horn Counties and was locally destructive in beans, it is not known to have an important connection with potato black leg in Montana. This entomological information was supplied by W. B. Mabee, Extension Entomologist of the Montana Agricultural Experiment Station.

VIROSES. Viroses appear to be the most serious diseases of potatoes in Montana. They are widely distributed and often spread rapidly when not controlled. They caused little loss in 1920. Since then, they have caused an annual reduction in yield of about 10 per cent. The mosaics are the most destructive of the viroses in Montana. They have been discussed by Whipple (1919) and Morris and Young (1929).

_Solanum nigrum_ L., _S. triflorum_ Nutt., _S. douglasii_ Dunal., _S. dulcamara_ L., and _S. rostratum_ Dunal. occur in Montana but are not known to be important in the spread of potato viroses.

MOSAICS (Viruses). Rugose mosaic, crinkle mosaic, and mild mosaic are common and destructive in potato fields in Montana. In this preliminary survey of 16 fields in 10 counties, there was an average of 4.2 per cent of rugose and crinkle mosaics in 39 acres. Some of these fields had been planted with certified potatoes.

Mosaics caused most of the 10 per cent annual loss from viroses in Montana since 1921.

CURLY MOSAIC (Virus?). What appears to be a new mosaic disease was found at Bozeman in Bliss Triumph potatoes in 1927. Its symptoms are prominent curling and marginal flavescence (chlorosis), dwarfing and diffuse mottling of the leaves, dwarfing and brittleness of the stems, and severe reduction in yield (Plate I, A). Only a few plants were found. Attempts to transmit this disease are in progress. A similar disease was seen in experimental plots at Corvallis, Oregon, in 1928.

WITCHES' BROOM (Virus). Witches' broom has become common in Montana potato fields in recent years, but usually it is not sufficiently abundant to be serious and generally does not spread rapidly. A severe infestation occurred in Yellowstone County in which 18 acres of Triumph potatoes had 10 per cent of the hills affected with witches' broom. In Wheatland County, a 5 acre field had witches' broom in 1 per cent of the hills and 4 per cent of the potatoes in a half-acre field in Sweet Grass County had this disease. Young (1927) and Young and Morris (1926, 1928) have described witches' broom in Montana.

LEAF ROLL (Virus). Low percentages of leaf roll commonly occur in many potato fields in Montana, but it usually is not serious. There was 1 per cent leaf roll in a 1 acre field in Yellowstone County. Traces to 2 per cent were found in fields in three other counties. Leaf roll caused about a 2 per cent loss in Montana potatoes in 1921.

SPINDLE TUBER (Virus). Spindle tuber is common and destructive in Montana. Nine fields in 8 counties averaged 5 per cent spindle tuber of discernible severity.

CALICO (Undetermined). Traces of calico were seen in Yellowstone, Stillwater, Gallatin, and Ravalli Counties.

It was found in Netted Gem potatoes in Missoula County in 1924.

GIANT HILL (Undetermined). Low percentages of giant hill plants commonly occur in potato fields in Montana. Potatoes affected with it were grown experimentally at Bozeman in 1928.

TIP BURN (Sun burn and leaf hoppers). Tip burn occurs in eastern Montana, but usually is not serious. It was not reported in 1928.

HOLLOW HEART (Nonparasitic). This injurious condition commonly occurs in large potato tubers throughout the state.

## TOMATO (Lycopersicon esculentum Mill.)

EARLY BLIGHT (Alternaria solani (E. & M.) J. & G.). A mild infestation of early blight was found in a 2 acre field of tomatoes at Billings in 1927. It was not seen in 1928.

WILT (Fusarium lycopersici Sacc.). Wilt caused a loss of 3 per cent in a three acre field of Bonny Best tomatoes in Flathead County in 1924.

MOSAIC (Virus). A one acre field of tomatoes at Miles City contained 26 per cent of mild mosaic. Bonny Best and Earliana tomatoes in the greenhouse of the Montana Agricultural Experiment Station at Bozeman have been affected by mild mosaic. This mild form of mosaic does not appear to reduce tomato yields seriously.

WITCHES' BROOM (Virus). This disease occurred under experimental conditions in the greenhouse of the Montana Agricultural Experiment Station at Bozeman from 1927 to 1928. It was described by Young and Morris (1927, 1928).

NEMATODES (Species undetermined, probably Caconema radicicola (Greef.) Cobb). A serious infestation of nematode galls appeared on the roots of Bonny Best and Earliana tomatoes in the greenhouse at Montana State College in 1927. They caused severe chlorosis. They were not seen after the application of drastic control measures.

### TOBACCO (*Nicotiana tabacum* L.)

WITCHES' BROOM (Virus). Witches' broom appeared in White Flowering tobacco plants grafted onto tomatoes with witches' broom in the greenhouse at Montana State College. It was described by Young (1929).

### CABBAGE (Brassica oleracea L.)

WATERY SOFT ROT (Sclerotinia libertiana Fckl.). This soft rot was found at Bozeman in 1922.

### LETTUCE (*Lactuca sativa capitata* L.)

MOSAIC (Virus). Mosaic of lettuce was found in Montana for the first time in 1928.

At Bozeman, 5 acres of young head lettuce contained 3 per cent mosaic. Traces were seen in an old half-acre field and in a field at Billings. The plants were very chlorotic and exhibited prominent intervenal mottling. Affected plants were dwarfed.

HEAD ROT (~~Bacterial~~ Bacterium spp. Undetermined). Bacterial head rot of lettuce was destructive in Montana. In Ravalli County, 75 per cent of the plants in 0.5 acres of head lettuce were damaged. In Gallatin County, it destroyed 75 per cent of the heads in a quarter-acre field. About 40 per cent of the heads were rotted in an old 1-acre field. It was abundant in a field in Flathead County. The grower there said that he lost $100.00 from this disease one year. A mild infestation was found in a field in Yellowstone County. Identification and control work is needed for this disease.

DROP (*Sclerotinia libertiana* Fuckel). Sclerotinia was experimentally transferred from sunflowers to lettuce in the greenhouse and field at Bozeman. Young and Morris (1927) have discussed Sclerotinia and the reason for retaining the commonly known specific name, libertiana.

### FRENCH ENDIVE (*Cichorium endivia* L.)

CENTER ROT (*Phytomonas cichori* D. B. Swingle and *P. intybi* D. B. Swingle). These diseases were described by Swingle (1925). An extensive grower in Flathead County reported serious damage from center rot. He found that the disease was most serious when the roots were grown in damp soil during the summer.

WATERY SOFT ROT (*Sclerotinia libertiana* Fckl.). This soft rot occurred in French endive roots grown in Bozeman near a plot of sunflowers seriously affected with Sclerotinia. It was a serious storage rot.

### SALSIFY (Tragopogon porrifolius L. and T. pratensis L.).

Albugo tragopogonis (DC.) S.F.G. is common in Montana.

### PARSNIP (Pastinaca sativa L.)

Botrytis cinerea Auct. caused a soft rot of parsnips, locally grown, in Bozeman.

### CARROT (Daucus carota sativa DC.)

Sclerotinia libertiana Fckl. occurred on locally grown carrots in storage at Bozeman.

### CELERY (Apium graveolens Dulce DC.)

LATE BLIGHT (Septoria apii Rostr.). At Hamilton, one-half acres of Golden Plume celery showed 10 per cent of the plants spotted by Septoria apii, but there was little damage because Bordeaux mixture was controlling the disease. A gardener at Billings reported that late blight occurred in his celery in 1927.

### ONION (Allium cepa L.)

SMUDGE (Vermicularia circinans Berk.). This disease occurred as a 1 per cent infestation in a half-acre field at Billings.

DODDER (Cuscuta arvensis Beyrich and C. gronovii Willd.). Dodder was found on onions at Missoula in 1927.

### HORSERADISH (Radicula armoracia (L.) Rob.).

LEAF SPOT (Ramularia armoraciae Fckl.). A mild infestation of this fungus was found at Kalispell.

### WILD CUCUMBER (Echinocystis lobata Torr. & Gray)

MOSAIC (Virus). Cucumber mosaic was collected in Bozeman in 1927.

## SUGAR BEET (*Beta vulgaris* L.)

CURLY TOP (Virus). Curly top was found in sugar beets by Walter Carter in Yellowstone County in 1926. He transmitted it from collected material to prove its identity.

W. B. Mabee, Extension Entomologist, M.S.C., reported that *Eutettix tenella* Baker has been found in Stillwater, Park, Jefferson, Lewis and Clark, Ravalli, Missoula, Lake and Sanders Counties during the last few years.

With both curly top and its insect vector in the state in widely separated localities, it is feared that serious spread of curly top may occur. It has not yet done recorded economic damage in Montana. It was found in red beets and mangel wurzels in western Montana.

BLACK ROOT (Probably *Phoma betae* (Oud.) Frank (*Mycosphaerella tabifica* P. & D. Johns). Black root was found in three plots at the Agricultural Experiment Station at Huntley in large beets on July 29, 1928. An average of 1 per cent of the roots were ruined by black root. Presumably the percentage of seedling infestation was higher. Superintendent Dan Hansen stated that black root sometimes spoils stands of sugar beets in Yellowstone County. Traces of black root were found in two fields in Yellowstone County. Although black root was not seen in Rosebud County on July 30, a farmer there said that it sometimes was destructive. The leaf spot stage (*Phyllosticta betae* Oud.) was collected at Billings in 1916 and 1927.

LEAF SPOT (*Gloeosporium betae* Dearn. and Barth.) (Fungi Columbiani No. 5023); described from Billings in 1913.

## RED BEET (*Beta vulgaris* L.)

CURLY TOP (Virus). R. W. Haegele made two collections of curly top in red beets in Sanders County in 1926.

LEAF SPOT (*Cercospora beticola* Sacc.). A 100 per cent infestation was found to be doing slight damage in a garden near Billings.

## MANGEL-WURZEL (*Beta vulgaris macrorhiza*)

CURLY TOP (Virus). Curly top was found in mangels in Ravalli County in 1927 by W. B. Mabee, Extension Entomologist of Montana State College, and Walter Carter, Assistant Entomologist, United States Department of Agriculture.

## FORAGE CROPS

### ALFALFA (Medicago sativa L.)

Alfalfa seed - 1928. 16,500 acres; 39,600 bushels; $543,000.
Alfalfa hay: 610,000 acres in 1926.

YELLOW LEAF BLOTCH (Pyrenopeziza medicaginis Fckl.). Yellow leaf blotch is common and destructive in Montana. It was found in Park County.in 1925. Pyrenopeziza kills the tops of severely affected plants. It did great damage in some plots at Moccasin and in a field at Bozeman.

Thirteen fields covering 169 acres in the counties shown in Figure 7 contained yellow leaf blotch as the predominating serious disease. In these, 83 per cent of the plants were affected by Pyrenopeziza, which destroyed 40 per cent of the leaf area. These inspections involved the first two crops.

Pyrenopeziza was serious in combination with Pseudopeziza in eight other fields covering 270 acres. In these, 83 per cent of the plants with 16 per cent of the leaf area were affected by these fungi. Since destruction of leaf area is not directly correlated with reduced yields, losses cannot be determined readily. However, these fungi cause serious, premature shedding of the leaves, so they probably cause an economic loss of at least 5 per cent in Montana. They are most destructive in seed fields, since cutting hay crops at the proper time usually prevents serious damage from them in Montana and seed fields are not thus protected.

The average infestation for the state is probably a little lower than the percentages summarized from the limited field inspections.

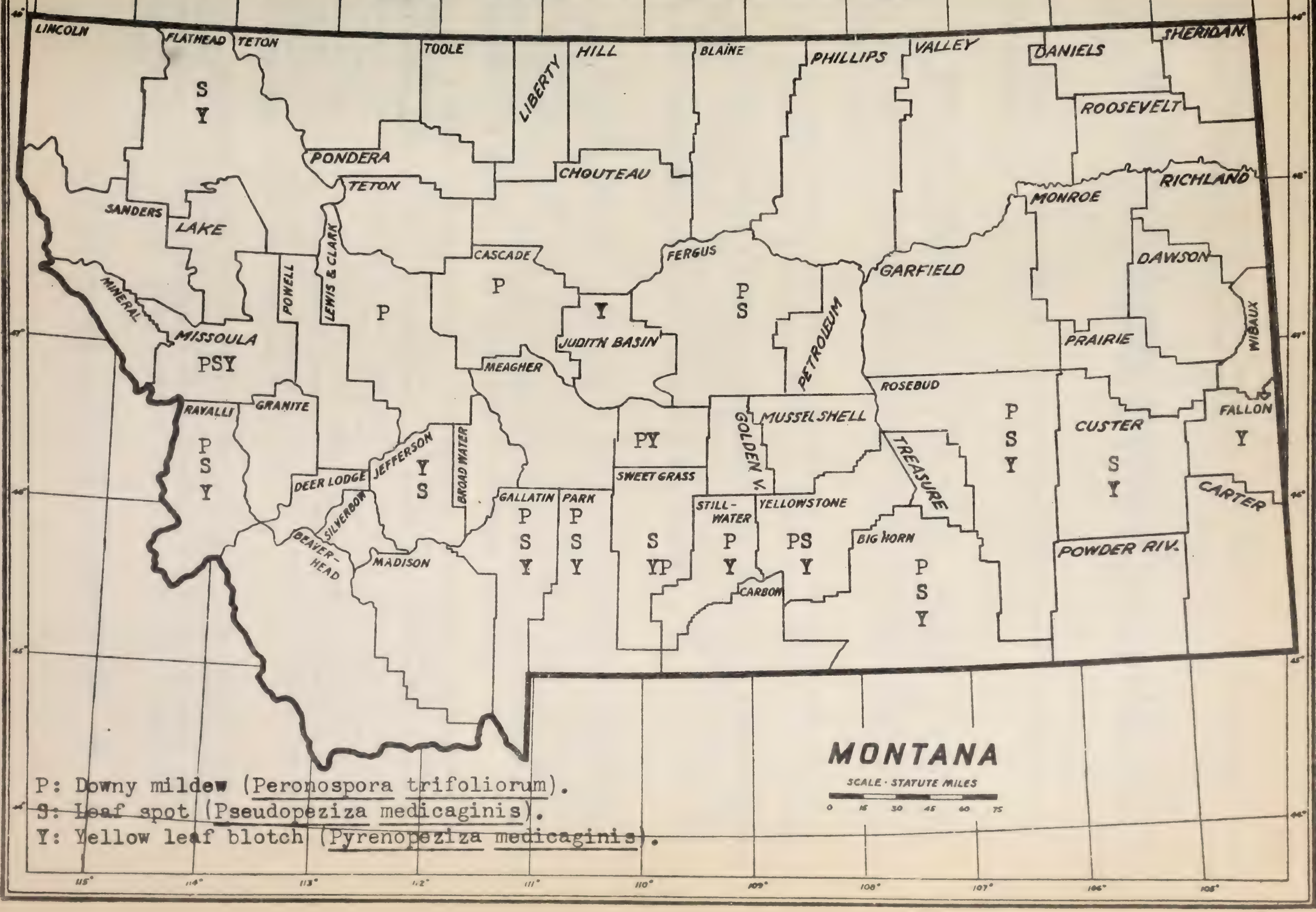
LEAF SPOT (Pseudopeziza medicaginis (Lib.) Sacc.). This disease is common and sometimes destructive in Montana. Its prevalence and destructiveness in combination with Pyrenopeziza is discussed under Yellow Leaf Blotch.

In 15 fields covering 338 acres in the counties shown in Figure 7, Pseudopeziza was the only parasite present in destructive abundance. All the plants were diseased by it. Although most of the spots were on the lower half of the leaves, about 29 per cent of the leaf area of the plants was destroyed by the spots, exclusive of the premature partial defoliation due to this leaf spot.

Pseudopeziza and Pyrenopeziza are most injurious in seed fields where cutting is too late to control them.

DOWNY MILDEW (Peronospora trifoliorum Deby.). This common disease is usually not very destructive in Montana. It was found in 19 fields covering 474 acres in the counties indicated in Figure 8. In eight of these fields,

Fig. 8. Alfalfa Diseases in Montana, 1928.



P: Downy mildew (Peronospora trifoliorum).
S: Leaf spot (Pseudopeziza medicaginis).
Y: Yellow leaf blotch (Pyrenopeziza medicaginis).

50 to 100 per cent of the plants bore one to 15 spots of downy mildew per plant. The other infestations were milder than these.

BACTERIAL BLIGHT (Phytomonas medicaginis (Sack.) Com. S.A.B.). A mild infestation of bacterial blight was found in a 15 acre field in Sweet Grass County.

MOSAIC (Virus). Traces of alfalfa mosaic were found in Gallatin and Fergus Counties.

WHITE SPOT (Unbalanced water relationships). Specimens of white spot of alfalfa were collected in Lewis and Clark, Gallatin, Park, and Sweet Grass Counties in 1928. It was not previously reported in Montana. This disease was described by Richards (1929) who kindly checked the identification of one Montana sample.

In Park County, 1 per cent of the plants in a 40 acre field had white spot. In other fields, scattered groups of plants were found to be affected.

Plants severely affected by white spot were abundant in a non-irrigated field in Gallatin County, so this abnormality is not always associated with irrigation. However, it was found only in an irrigated spot in a field near Helena. White spot was found only during May and June.

TIP BURN (Drouth?). The tips of the leaflets were brown and nearly dead on 0.25 per cent of the alfalfa plants in a 20 acre field in Lewis and Clark County. The plants occurred only in the unirrigated part of the field in contrast to plants with white spot which were found only in an irrigated part of this field. No serious amount of tip burn was found elsewhere. This resembles the marginal injury described by Richards (1929).

ALBINISM (Non-parasitic). This peculiar abnormality has occurred in Park County for more than ten years. G. A. Rassley, County Agricultural Extension Agent, sent in one collection of albino plants from Yellowstone County. Albino plants have been found only in the first crops of alfalfa each year, so calling the trouble a genetic abnormality is rather uncertain. However, since there are usually some normal leaves and stems produced by alfalfa plants that bear albino stems and leaves, perhaps these aberrant plants have the abnormality in genetic form, and express it only under the growing conditions of the first crop.

In severe cases, the stems and leaves are greatly dwarfed and slender, and are white, yellow, pink or purple in color. Such stems sometimes die prematurely, for they are entirely dependent upon the plants to which they are attached. In milder cases, normally green stems bear one to many white or yellow leaflets.

Albino plants were transplanted to the greenhouse in 1926. The new crop of stems and leaves were all normal and like the check plants so their behavior in the greenhouse was the same as it was in the field.

Albino plants were found in five fields of alfalfa in Park County in 1928. Traces to 1 per cent of albino plants occurred in four of these fields In the other field, 25 per cent of the plants in one acre at one end of the field were albino.

DODDER (Cuscuta sp.). R. B. Streets found alfalfa dodder at Bozeman in 1916, 1917, 1918. It was also found in western Montana.

### OTHER PARASITES OF ALFALFA.

*Urophlyctis alfalfae* (Lagerh.) Magn. was found in Lake County by Braff (1928).

*Rhizobium leguminosarum* Frank commonly causes nodules on alfalfa roots.

## SWEET CLOVER (*Melilotus alba* Desr., *M. officinalis* Lam. and *M. indica* All.)

1928: 7,000 acres; 31,500 bushels; $135,000.

Fields of yellow sweet clover exhibited no diseases.

LEAF SPOT (*Septoria meliloti* (Lasch.) Sacc.). Septoria leaf spot was found in white sweet clover growing along roads in Yellowstone and Treasure Counties. This appears to be the first report of it in Montana.

ALBINISM (Undetermined). In Sweet Grass County, one plant of white sweet clover showed symptoms of albinism resembling albinism of alfalfa. No previous reports of this abnormality are available.

WILT (*Sclerotinia libertiana* Fckl.). Diseased roots of sweet clover were sent to the laboratory in 1927. Cultures revealed *Sclerotinia libertiana* as the cause of the disease.

STEM ROT (*Corticium vagum* B. & C.). Reported in United States Department of Agriculture Bulletin 1366.

MOSAIC (Virus). Traces of mosaic were found in white sweet clover in Lewis and Clark Counties.

## RED CLOVER (Trifolium pratense L.).

POWDERY MILDEW (Erysiphe polygoni DC.). Clover mildew was found in Gallatin, Ravalli, Missoula, and Flathead Counties. It was abundant at Bozeman and Missoula. Probably it is widely distributed in Montana. It is not serious.

ANTHRACNOSE (Gloeosporium caulivorum Kirch.). Anthracnose did great damage in three plots of red clover of the Agronomy Department at Bozeman. All the stems and most of the leaves, especially the upper ones, were affected. Spores finally appeared on the lesions in September, permitting the identification of the causal parasite. Anthracnose was so destructive that it is hoped that it will not invade commercial fields. Seed from Tennessee may have brought this disease into Montana.

RUST (Uromyces fallens (Desm.) Kern.)(Nigredo). Reported by Arthur (North American Flora 7: 830).

LEAF SPOT (Pseudopeziza trifolii (Biv.) Fckl.). Leaf spot was abundant on red clover in an apple orchard in Ravalli County. It is regarded as a dangerous parasite.

MOSAIC (Virus). Traces of mosaic were found in red clover in Gallatin and Ravalli Counties.

RING SPOT (Possibly virus). Traces of ring spot in red clover were found in an Agronomy Department plot at Bozeman. The identification of the disease was checked by Dr. S. A. Wingard, Plant Pathologist of the Virginia Experiment Station. Its affinities are unknown.

NODULES (Rhizobium leguminosarum Frank) are common on red clover. They are mainly beneficial.

## ALSIKE CLOVER (Trifolium hybridum L.).

Erysiphe polygoni DC. in Gallatin County in 1919.
Septoria compacta Sacc. in Stillwater County.
Uromyces trifolii (Hedw.) Lev. Fifteen per cent of the plants in a 2 acre field in Stillwater County were rusted. The damage was slight.

## WHITE CLOVER (Trifolium repens L.) pasture crop.

Erysiphe polygoni DC. in Sanders County in 1901.

*Phyllachora trifolii* (Pers.) Fckl. in Gallatin County.
*Pucciniola nerviphila* (Grognot) Arth. N.A.F.7: 843).
*Uromyces trifolii* (Hedw.) Lev. in Gallatin County in 1915 and 1928.

## SUNFLOWER (*Helianthus annuus* L.)

The acreage of sunflowers in Montana has become very small.

WILT (*Sclerotinia libertiana* Fckl.). A few wilted plants were found in a small plot of sunflowers at Bozeman in 1928. Young and Morris (1927), Morris and Swingle (1921), and Swingle (1921) described this disease in Montana. The name *S. sclerotiorum* (Lib.) Mass. is incorrect on the basis of priority became *S. sclerotiorum* (Lib.) Schroet is two years older. This is not in common use, so the commonly known name, *S. libertiana* Fckl., is retained.

DOWNY MILDEW (*Plasmopara halstedii* (Farl.) Berl. & Detoni). Traces of downy mildew were found at Bozeman in 1928. This is quite a contrast to the condition in 1927 when 5 per cent of the plants in 5 acres of Mammoth Russian sunflowers at Bozeman were mottled and dwarfed by Plasmopara, with 25 per cent of the plants affected in one part of the field. This field was summer fallowed in 1928. Young and Morris (1927) and Young, Jellison and Morris (1929) described this disease in Montana.

RUST (*Puccinia helianthi-mollis* (Schw.) Jackson). Sunflower rust was found in Prairie County in 1928. It was previously reported in Gallatin, Ravalli, and Yellowstone Counties. It is not serious.

OTHER PARASITES OF CULTIVATED SUNFLOWERS.
*Botrytis cinerea* Pers. (head rot). Gallatin County in 1925.
*Entyloma compositarum* Farlow. (Kelsey, 1889).
*Entyloma polysporum* (Pk.) Farl. (United States Department of Agriculture Bulletin 1366).
*Erysiphe cichoracearum* DC. (Griffiths, 1899).
*Macrosporium inquinans* C. & E. (Anderson, 1889).
*Penicillum* sp. (green head mold). Gallatin County 1925.
*Septoria helianthi* E. & K. Yellowstone County in 1915. (Bartholomew, *Fungi Columbiani* No. 4984).

## OTHER FIELD CROPS

## FLAX (*Linum usitatissimum* L.)

1928: 196,000 acres; 1,666,000 bushels; $3,199,000.

No diseases were seen in four fields of flax aggregating 135 acres in Fallon and Rosebud Counties.

WILT (Fusarium lini Bolley). Flax wilt occurs in the eastern part of Montana and causes an annual loss of about 1 per cent. It was found in Roosevelt County in 1928. It was determined and studied experimentally at Bozeman in 1914 and 1915. Wilt damaged some common flax in Judith Basin County in 1926 according to A. C. Dillman, Flax Investigator, United States Department of Agriculture.

ANTHRACNOSE (Colletotrichum linicolum Peth. and Laf.). Anthracnose occurs in the eastern part of Montana, but serious damage is not ascribed to it. It was not reported in 1928.

HEAT CANKER (Nonparasitic). Although occasionally destructive, heat canker is usually not very serious. It occurs in the eastern part of Montana. Traces were found in Judith Basin County in 1928.

RUST (Melampsora lini (Schum.) Desm.). Mr. L. D. Kurtz, Extension Agronomist of Montana State College, found an infestation of 100 per cent rust in 40 acres of Budda flax in Roosevelt County. Traces of rust were found in the adjacent edge of a 125 acre field of Reserve flax. No rust was seen in a 6 acre field of Newland flax near the above fields.

Flax rust is common, but is usually not destructive. Melampsora lini occurs on Linum lewisii in Gallatin County. Flax rust was considered by Atkinson and Swingle (1911).

## SAFFLOWER (Carthamus tinctorius L.).

BLACK ROOT (Undetermined). Black root disease was seriously abundant in 1927 and 1928 in experimental plots of safflowers on the Agricultural Experiment Station at Huntley. The symptoms consist of blackening of the tap roots, decay of branch roots, and browning and drying of the leaves. A species of Alternaria was isolated from diseased roots.

In 1928, three plots of one-quarter acre each at Huntley showed 2, 2, and 10 per cent of the plants killed by this disease. A species of Cladosporium was abundant on the dead leaves.

Research work on this root rot will be necessary when safflowers are grown commercially.

## VETCH (*Vicia* spp.)

*Aecidium porosum* Pk. (Kelsey, 1889).
*Kabatiella nigricans* (Atk. & Edgert.) Karak.
*Erysiphe polygoni* DC. (Anderson, 1889).
*Microsphaera alni* Wallr. (Jones, 1910).
*Nigredo fabae* (Pers.) Arth. (N.A.F. 7:761).
*Uromyces albus* D. & H. Gallatin County 1900. (N.A.F. 7:450).
*Uromyces hedysari-obscuri* DC. Gallatin County 1898.

## HEMP (*Cannabis sativa* L.)

WILT (*Sclerotinia libertiana* Fckl.). Resulted from root inoculations at Bozeman in 1925. It was described by Young and Morris (1927).

## FRUITS

Swingle (1914) described fruit diseases in Montana.

## APPLE (*Pyrus malus* L.)

SCAB (*Venturia inaequalis* (Cke.) Aderh.). Apple scab is abundant in western Montana. The annual damage in sprayed orchards is 5 to 8 per cent and is 25 per cent or more in unsprayed orchards. Scab caused about 5 per cent damage in sprayed orchards in 1928 in Ravalli, Lake, and Flathead Counties.

Thirteen apple orchards aggregating 835 acres were inspected in western Montana in 1928. Only traces of scab were seen in the well sprayed orchards in Ravalli County.

Morris (1914), Morris and Parker (1914), Cooley and Swingle (1912), Swingle and Morris (1907-1922), and Swingle (1909-1911) give information concerning apple scab in Montana.

BLIGHT (*Erwinia amylovora* (Burr.) Com. S.A.B.). In Bozeman, 20 to 70 per cent of the twigs on 175 trees were killed by blight. Near Missoula, 50 per cent of the twigs were killed in a 1-acre orchard, but none was seen in two orchards covering 120 acres. Near Hamilton, 70 per cent of the twigs were killed in a 1-acre orchard. However, little or no blight was seen in the large commercial orchards of western Montana in 1928. Blight has caused little commercial damage in this region since the most susceptible varieties were removed. Swingle (1910, 1911, 1914, 1921) described fire blight in Montana.

CANKER (Valsa spp.) (Cytospora spp.). Cytospora cankers were found in three orchards in Ravalli County. This disease is common in commercial orchards and is sometimes destructive. Valsa leucostoma is common.

CROWN GALL (Phytomonas tumefaciens (E.F.S. & Town.) Com. S.A.B.). Although crown gall did some damage in western Montana due to the importation of poor nursery stock, it has not been serious in recent years. It is present in many orchards. It was described by Swingle and Morris (1918).

BITTER PIT (Abnormal water relationship). Bitter pit was serious on scattered trees in an orchard in Ravalli County in 1910. The spots were large, and so severe that the apples were badly distorted. It was found at Billings in 1913.

WATER CORE (Physiological). Water core was found in Northwest Greening apples in Flathead and Ravalli Counties in 1910.

FRUIT CRACKING (Nonparasitic). Scattered trees in a few commercial orchards in Ravalli County bore some badly cracked fruit (Plate I,B). Spray burn was eliminated as a cause in most cases. This cracking was probably due to frost injury when the fruit was very small. McLarty (1928) has described such fruit cracking.

BROWN BARK SPOT (Nutritional disorder). Brown bark spot was abundant and destructive in western Montana for five years about 1910, but thereafter ceased to be destructive. It was described by Swingle and Morris (1921).

BLACK HEART (Winter injury). Blackening of apple heart wood is commonly seen in western Montana in most years and was abundant in 1906, 1910, 1917, and 1924 following severe winter injury to orchards.

OTHER PARASITES OF APPLES IN WESTERN MONTANA.

Neofabraea malicorticis (Cordley) Jack. (United States Department of Agriculture Bulletin 1366).

Fomes fomentarius (L.) Fr. (United States Department of Agriculture Bulletin 1366).

Podosphaera leucotricha (E. & E.) Salm. or P. oxyacanthae (DC.) DeBy. In western Montana.

## PEAR (Pyrus communis L.)

Few pear trees grow in Montana. The following diseases have been reported on pears in western Montana.

BLIGHT (*Erwinia amylovora* (Burr.) Com. S.A.B.). Serious several years ago.

*Fabraea maculata* (Lev.) Atk. Leaf blight.
*Venturia pyrina* Aderh. scab. First found in western Montana in 1912.
Brown bark spot (Nutritional disorder).

## SOUR CHERRY (*Prunus cerasus* L.)

**POWDERY MILDEW** (*Podosphaera oxyacanthae* (DC.) DeBy. Cherry mildew occurs as mild infestations in western Montana.

YELLOW LEAF (Nonparasitic). This abnormality has resulted in 5 to 25 per cent defoliation in a few Morello orchards in Ravalli County during recent years. It is practically absent in most orchards. Yellow leaf seems to be associated with winter injury and infertility of the soil.

GUMMOSIS (Sun scald and winter injury). Serious gummosis affects cherries in Ravalli County, especially trees from 1 to 3 years old. Most of the injuries occur on the south and west sides of the trunks.

BROWN BARK SPOT (Nonparasitic). Reported by Swingle and Morris (1921).

LEAF SPOT (Undetermined). Leaf spots were common in one orchard of English Morello cherries in Ravalli County. They probably were not caused by Coccomyces. They were associated with the yellow leaf abnormality.

## SWEET CHERRY (*Prunus avium* L.)

LEAF SPOT (*Coccomyces hiemalis* Hig.). Coccomyces was seriously abundant in Flathead County in about 1924. Partial defoliation injured some trees.

BROWN ROT (*Sclerotinia fructicola* (Wint.) Rehm.). Professor D. B. Swingle found brown rot damaging sweet cherries along Flathead Lake in 1908. The season was unusually rainy and Sclerotinia grew in cracks in the ripening fruit. Brown rot has not been reported in Montana since that time. Apparently *S. fructicola* is usually unadapted to the conditions where cherries grow in Montana.

GUMMOSIS (Nonparasitic). Gummosis does annual damage to sweet cherries in Flathead County.

CHOKE CHERRIES (*Prunus melanocarpa* (Nels.) Rydb.)

BLACK KNOT (*Plowrightia morbosa* (Schw.) Sacc.). Black knot is common on choke cherries in Gallatin County, Flathead County and in western Montana, and is sometimes destructive to this valuable species of native fruit tree. However, black knot has not been reported on *Prunus cerasus* or *P. avium.* Perhaps these cultivated species of Prunus are not susceptible to the form of *Plowrightia morbosa* that occurs on *Prunus melanocarpa.*

OTHER PARASITES ON CHOKE CHERRIES.

*Coccomyces hiemalis* Hig. Gallatin County, 1925. Flathead County, 1928.

*Creonectria purpurea* (L.) Seaver. Gallatin County.

*Cytospora chrysosperma* (Pers.) Fr. (United States Department of Agriculture Bulletin 1366).

*Monilia seaveri* Reade. Madison County, 1914.

*Phyllosticta destruens* Desm. Carbon County, 1915.

*Phyllosticta virginianae* (E.& H.) Seaver. (United States Department of Agriculture Bulletin 1366).

*Phytomonas pruni* (E.F.S.) Com. S.A.B.

*Podosphaera oxyacanthae* (DC.) DeBy. (Jones, 1910).

PLUM (*Prunus domestica* L. & *P. americana* Marsh.).

POWDERY MILDEW (*Podosphaera oxyacanthae* (DC.) DeBy.). Plum mildew was found in Flathead County in 1908 by Professor D. B. Swingle.

BLIGHT (*Erwinia amylovora* (Burr.) Com. S.A.B.). Fire blight damaged De Soto plums slightly at Bozeman in 1928.

It was serious on another tree of *P. americana.*

BACTERIAL SPOT (*Phytomonas pruni* (E.F.S.) Com. S.A.B.). Bacterial spot destroyed 60 per cent of the leaf area on two trees of compass plums at Billings in 1928.

POCKETS (*Exoascus pruni* (Berk.) Fckl., & *E. communis* Sadeb.). Swingle and Morris (1918) described the damage these fungi do in Montana. Specimens of *E. pruni* were collected in Yellowstone County in 1927.

LEAF CURL (*Exoascus decipiens* Atk.). *Prunus americana* in Fergus County was severely affected by leaf curl in 1928. It was described by Swingle and Morris (1918).

YELLOWS (Undetermined). One hybrid plum at the Agricultural Experiment Station at Corvallis, Ravalli County, bore clusters of yellow, dwarfed leaves.

These are like the symptoms of peach yellows.

PEACH (Amygdalus persica L.).

Peaches were cultivated near Flathead Lake about 1908, but are now rather rare in Montana.

MILDEW (Podosphaera oxyacanthae (DC.) DeBy.). Peach mildew was found in Flathead County in 1908.

BACTERIAL SPOT (Phytomonas pruni (E.F.S.) Com. S.A.B.). Bacterial spot was found on peach leaves in Flathead County in 1908.

LEAF CURL (Exoascus deformans (Berk.) Fckl.). Peaches in Flathead County were seriously injured by leaf curl in 1908 and 1912.

BLACK RASPBERRY (Rubus occidentalis L.).

MOSAIC (Virus). Mosaic was found in Yellowstone and Ravalli Counties in 1928. It was not serious.

RUST (Gymnoconia interstitialis (Schl.) Lagh.). Rust was found in Bozeman in 1910.

LEAF SPOT (Didymosphaeria manitobensis E. and E.). Collected in Lake County, August 28, 1928 by W. L. Jellison on Rubus leucodermis Dougl. which is considered by some as a variety of R. occidentalis. First report from Montana.

BRAMBLE STREAK (Virus). Bramble streak was found on two stems of black cap raspberries at the Agricultural Experiment Station at Huntley.

RED RASPBERRY (Rubus idaeus L.)

MOSAIC (Virus). Mild mosaic affected 90 per cent of the plants in a one-acre field of Latham and King raspberries at Missoula, but appeared to be doing no serious damage yet. Mosaic was also found in red raspberries at Billings.

PURPLE RASPBERRY (Rubus neglectus Peck.)

MOSAIC (Virus). Mosaic was found in a small patch of purple raspberries in Ravalli County.

## DEWBERRY (Rubus flagellaris Willd.)

LEAF SPOT (Mycosphaerella rubi Roark). Collected by H. M. Jennison, August 25, 1916, at Glendive. Determined by P. A. Young, April 22, 1929. Apparently first authentic record for state.

MOSAIC (Virus). Mosaic was found in Ravalli County.

## LOGANBERRY (Rubus loganobaccus Bailey).

Mosaic was found on Loganberry in Ravalli County.

## BLACKBERRY (Rubus allegheniensis Porter).

CROWN GALL (Phytomonas tumefaciens (E.F.S. & Town.) Com. S.A.B.). Crown gall was found on blackberries in Ravalli County in 1916. It was also found in Flathead County. Swingle and Morris (1918) discussed crown gall.

RUST (Gymnoconia interstitialis (Schl.) Lagh.). Rusted blackberries were found in Bozeman in 1908.

## STRAWBERRY (Fragaria vesca L. in part)

YELLOWING (Virus). Yellow, Everbearing strawberries were found in Ravalli, Gallatin and Yellowstone Counties in 1928. A few yellow Parson's Pride strawberries were found in Flathead County. Yellow strawberry plants have occurred in Ravalli County for more than five years. They were found in Lewis and Clark Counties in 1925 and in Pondera and Sweet Grass Counties in 1926.

Everbearing strawberries from Ravalli and Gallatin Counties were grown in the greenhouse at Bozeman for six months and constantly showed the symptoms of general and marginal flavescence (Young and Morris (1928)) and diffuse mottling.

Yellowing caused considerable damage in Ravalli County in 1928. There the strawberries in six fields aggregating 25 acres showed some yellowing in 39 per cent of the plants. This percentage was probably too low because the inspections were made in August when the symptoms were partially masked by hot weather.

A garden patch of strawberries in Missoula County showed yellowing in 30 per cent of the plants. Some yellow plants were found in a truck garden near Billings. These plants had come from Ravalli County. Two garden patches of strawberries near Bozeman contained so many yellow plants that they were nearly worthless.

The characteristic symptoms of the yellowing disease are marginal flavescence and diffuse mottling of leaves, dwarfing, reduced yields, too many stems, and usually a general flavescence of the plants. Stunting is severe in badly affected plants. These symptoms are very similar to those described by Plakidas (1927) for strawberry xanthosis. Experiments are now planned to determine if this yellowed condition and xanthosis are identical. Controlled transmission experiments in Montana have not yet been made.

BACTERIAL LEAF SPOT (Undetermined). A bacterial leaf spot of standard varieties of strawberries was found in Ravalli County in 1927 and 1928, and in Gallatin County in 1928. It is not yet serious. All the plants were affected by this disease in a small patch at Hamilton. It resembles the strawberry leaf spot described by Linford (1928).

The leaf spots are brown and angular, single spots often affecting half or large parts of the leaflets. Yellow droplets of bacterial exudate sometimes occur hypophyllously on the main veins. Large hypophyllous areas are brown or purple.

LEAF SPOT (Mycosphaerella fragariae (Tul.) Lind.). Mild infestations of strawberry leaf spot were found in Rosebud and Flathead Counties. It was previously found in Sanders (in 1909) and Ravalli Counties. A similar leaf spot is common on wild strawberries in Gallatin County.

LEAF SCORCH (Diplocarpon earliana (E. & E.) Wolf). W. L. Jellison found wild strawberries in Flathead County affected with leaf scorch. It is reported in United States Department Bulletin 1366.

**POWDERY** MILDEW (Sphaerotheca humuli (DC.) Burr.). Powdery mildew was found in Bozeman (greenhouse) in 1928 and in Ravalli County in 1916.

ASCOCHYTA COLORATA Pk. Dr. F. D. Kelsey found it on Fragaria vesca in Helena in 1888.

### SERVICE BERRY (Amelanchier alnifolia Nutt. and A. spp.)

This is a valuable native fruit tree.
Aecidium cornutum (Jones, 1910).
Dimerosporium collinsii (Schw.) Thuem. Gallatin County. Common.
Erysiphe polygoni DC. (Kelsey, 1889; U. S. D. A. Bulletin 1366).
Fabraea maculata (Lev.) Arth. (Kelsey, 1889).
Gymnosporangium clavariaeforme (Jacq.) DC. (N.A.F. 7: 825, Seymour, 1889).
Gymnosporangium nelsoni Arth. (N.A.F. 7: 826; Gallatin County in 1898, Jones, 1910).
Plowrightia morbosa (Schw.) Sacc. (U. S. D. A. Bulletin 1366).

## HAWTHORN (Crataegus spp.)

Cylindrosporium brevispina Dearn. (U.S.D.A.Bulletin 1366).
Gymnosporangium betheli Kern. (N.A.F.).
Gymnosporangium germinale (Schw.) Kern. (N.A.F. 7: 739).
Gymnosporangium tubulatum Kern. Gallatin County, 1898. (N.A.F.).
Phyllactinia corylea (Pers.) Karst. Gallatin County, 1919. (Griffiths, 1889).
Roestelia lacerata (Sow.) Fr. (Seymour, 1889).
Roestelia tubulata Kern. (Jones, 1910).

## CURRANT (Ribes sativum Syme)

ANTHRACNOSE (Pseudopeziza ribis Kleb.). Found in Gallatin County in 1926 and in Chouteau County in 1927. Common on Ribes saxosum in Gallatin County.

POWDERY MILDEW (Saphaerotheca mors-uvae (Schw.) B. & C.). A serious mildew occurred on the fruit of red currants in Ravalli County in 1927.

NECTRIA CINNABARINA (Tode) Fr. On currant stems in Bozeman, 1928. Silver Bow County, 1926.

MOTTLED LEAVES. Prominently mottled currant leaves were collected in Meagher and Silver Bow Counties in 1926.

## BLACK CURRANT (Ribes nigrum L.)

POWDERY MILDEW (Microsphaera grossulariae (Wall.) Lev.). F. W. Anderson collected it in Cascade County about 1888.

## GOOSEBERRY (Ribes grossularia L.)

POWDERY MILDEW (Sphaerotheca mors-uvae (Schw.) B. & C.). Reported from Yellowstone County in 1908 and Missoula County in 1915.

## HUCKLEBERRY (Vaccinium spp.)

The berries of Vaccinium are valuable as wild fruit in Montana. The parasites are:

Calyptospora columnaris (A. & S.) Kuehn. Gallatin (Jones, 1910; N.A.F. 7: 682 and 819).
Exobasidium vaccinii (Fckl.) Wor. Gallatin County 1898.

*Pucciniastrum myrtilli* (Schum.) Arth. (N.A.F. 7: 818).
*Rhytisma vaccinii* (Schw.) Fr. Gallatin County.

## ORNAMENTAL PLANTS

BUFFALOBERRY (*Shepherdia argentea* Nutt. & *S. caradensis* (L.) Nutt.). Buffaloberries are commonly used in jellies.

*Dicaeoma allenii* (Clint.) A.& F. Gallatin County 1900. (N.A.F. 7: 786).
*Puccinia coronata* Cda. (N.A.F. 7: 313).
*Sphaerotheca humuli* (DC.) Burr. (U.S.D.A. Bulletin 1366).

### CARNATION (*Dianthus caryophyllus* L.)

*Uromyces caryophyllinus* (Schrank.) Wint. In greenhouse at Bozeman. Common.

### CHINA ASTER (*Callistephus chinensis* Nees.)

YELLOWS (Virus). A few asters with yellows were found at Billings. The florist said that it sometimes destroyed his patches of asters.

### COLUMBINE (*Aquilegia spp.*)

*Dicaeoma clematidis* (DC.) Arth. (N.A.F. 7: 333).
*Erysiphe polygoni* DC. (Before 1928).
*Puccinia elymi* Westend. (N.A.F. 7: 333).
*Puccinia obliterata* Arth. Gallatin County. (Before 1928).
*Sphaerella aquilegiae* E. & G. (Ellis & Galloway, 1889).

### GLADIOLUS (Cultivated species)

MOSAIC (Virus). Mosaic was present in 1 per cent of the gladiolus plants in one nursery at Billings in 1928.

## GOLDEN GLOW (*Rudbeckia laciniata* L.)

The following parasites have been collected on golden glow in Montana during previous years:

*Aecidium compositarum* Mart. (Before 1928).
*Ramularia rudbeckiae* Pk. (U. S. D. A. Bulletin 1366).
*Uromyces perigynius* Hals. (U.S.D.A.Bulletin 1366). (N.A.F. 7: 752).
*Uromyces rudbeckiae* A. & H. (N.A.F. 7: 519).

## HOLLYHOCK (*Althaea rosea* Cav.)

RUST (*Puccinia malvacearum* Bert.). Serious on the hollyhocks on the Experiment Station at Huntley. It was also found in Ravalli, Lewis and Clark, Missoula, and Flathead Counties.

## IRIS (*I. missouriensis* and cultivated spp.)

*Didymellina iridis* (Desm.) Hoehn. Yellowstone, Missoula and Ravalli Counties.
*Macrosporium iridis* C. & E. (Anderson, 1889).
*Macrosporium iridicolum* E. & E. Gallatin County 1928.

## LARKSPUR (*Delphinium sp.*)

*Puccinia clematidis* (DC.) Lagh. (U.S.D.A. Bulletin 1366).

## LIGUSTRUM SP.

*Puccinia ligustri* E. & E. (N.A.F. 7: 552).

## RED OSIER (*Cornus stolonifera* Michx.)

*Phyllosticta corylea* (Pers.) Karst. (Seymour, 1889).
*Puccinia acuminata* Pk. (On Cornus *canadensis* L.) (Jones, 1910).
*Septoria cornicola* Desm. Gallatin County, 1913.

## PETUNIA (*P. violacea* Lindl.)

*Mosaic*. A mild mosaic of petunia is common in the greenhouse at Bozeman.

## ROSA (Cultivated and Wild Species)

The following species of fungi were collected on roses in Montana between 1888 and 1928.

DWARFING RUST (Ameris rosicola Arth). (Uromyces). Two stems of a wild rose near Bozeman were severely rusted and dwarfed in both stems and leaves, resembling raspberries rusted by Gymnoconia in their dwarfing and distortion.

OTHER FUNGI.

Diplocarpon rosae Wolf. Park County. In greenhouses. Not serious.
Phragmidium disciflorum (Tode) James. Ravalli County, 1914.
P. montivagum Arth. Common. (Jones, 1910).
P. mucronatum (P.) Lk. (Seymour, 1889).
P. rosae-acicularis Liro. Sanders County, 1901. (N.A.F.).
P. rosae-arkansanae Diet. on Rosa woodsii. Common.

Collected in Gallatin, Flathead, Blaine and Phillips Counties in 1898 to 1915. Determined by J. C. Arthur and H. S. Jackson in 1915. (N.A.F.7:823).

P. rosae-setigerae Diet. Gallatin County.
P. subcorticinum Mull. (Jones, 1910).
Sphaerotheca pannosa (Wall.) Lev. Park County.

## SNAPDRAGON (Antirrhinum majus L.)

RUST (Puccinia antirrhini Diet. & Holw.). Collected at Billings in 1928. Occurs in a greenhouse at Bozeman.

WILT (Undetermined). A florist at Billings said that this disease is very destructive with him, and is serious elsewhere in the United States. Only one specimen was found then.

## SNOWBERRY (Symphoricarpos albus Blake and spp.)

Native and cultivated snowberries in Montana bear the following fungi:

Aecidium abundans Pk. (Kelsey, 1889; Jones, 1910).
Cercospora symphoricarpi E. & E. Gallatin County, 1913; Valley County, 1900.
Microsphaera diffusa C. & P. (Kelsey, 1889; Anderson, 1889).
Plowrightia symphoricarpi E. & G. (Anderson, 1889).
Puccinia crandallii P. & H. Gallatin and Missoula Counties. (N.A.F. 7: 328).
Puccinia symphoricarpi Hark. (Jones, 1910; N.A.F. 7: 570).
Septoria symphoricarpi E. & E. Gallatin County, 1913. (U.S.D.A. Bulletin 1366).

### SPIRAEA (*S. lucida* Dougl. and Sp.)

*Cylindrosporium filipendulae* Thuem. Gallatin County, 1913.
*C. salicifoliae* (Tul.) Davis. Gallatin County.
*Septoria salicifoliae* (Trel.) E. & E. (Jones, 1910).

### VIOLET (*Viola spp.*)

*Puccinia violae* DC. (Kelsey, 1889) (Jones, 1910; N.A.F. 7:393).

### TRADESCANTIA (Cult. sp.)

Leaf spot. A translucent (bacterial?) leaf spot was common in the greenhouse at Bozeman from 1925 to 1928.

## DECIDUOUS TREES EXCEPT FRUIT TREES

### ALDER (*Alnus tenuifolia* Nutt. and Sp.)

*Cylindrosporium sp.* (U.S.D.A. Bulletin 1366).
*Cytospora umbrina* (Bon.) Sacc. Gallatin County, 1913. (Fungi Columbiani No. 4317).
*Exoascus spp.* (U.S.D.A. Bulletin 1366).
*Fomes igniarius* (L.) Fr. (U.S.D.A. Bulletin 1366).
*Microsphaera alni* (Wallr.) Lev.
*Phyllactinia corylea* (Pers.) Karst. (Griffiths, 1899).

### ASH (*Fraxinus campestris* Britt. & *F. lanceolata* Borck).

*Puccinia fraxinata* Arth. Big Horn County, 1901. (N.A.F. 7: 316).

### BIRCH (*Betula fontinalis* Sarg. (*B. occidentalis*).

*Fomes igniarius* (L.) Fr. (U.S.D.A. Bulletin 1366).
*Melampsoridium betulae* (Schum.) Arth. (N.A.F. 7: 680).
*Phyllactinia corylea* (Pers.) Karst. (Kelsey, 1889; U.S.D.A. Bulletin 1366).

RIVER BIRCH (Betula glandulosa Michx.)

Daldinia concentrica (Bolt.) Ces. & deNot. Gallatin County, 1928.
Melampsoridium betulae (Schum.) Arth. (Jones, 1910; N.A.F. 7:818).

MAPLE (Acer glabrum Torr.)

LEAF SPOT (Phyllosticta minutissima E. & E.).
Common and sometimes destructive in Gallatin and Park Counties.
Cylindrosporium acerinum Tracy & Earle. Gallatin County 1898.
Cytospora chrysosperma (Pers.) Fr. (U. S. Bul. 1366).
Phyllosticta minutissima(E. & E.).
Rhytisma acerinum (Pers.) Fr. Gallatin County. (Before 1928).
Septoria saccharina occidentalis E. & E. (Jones, 1910).

VINE MAPLE (Acer circinatum (Pursh)

Cytospora chrysosperma (Pers.) Fr. (U. S. Bulletin 1366).

BOX ELDER (Acer negundo L.)

Septoria acerella Sacc. (U.S. Bulletin 1366).

MOUNTAIN ASH (Sorbus spp.)

Cytospora chrysosperma (Pers.) Fr. Gallatin County, 1916. Common and serious disease.
Eutypella sorbi (Schm.) Sacc. Park County, 1927.
Gymnosporangium cornutum (Pers.) Arth. (U.S. Bulletin 1366).
G. nelsoni Arth. (N.A.F. 7:742).
G. juniperinum (L.) Mart. Gallatin County, 1892.
Valsa leucostoma (Pers.) Fr. (U.S. Bulletin 1366).

POPLARS (Populus spp.)

CANKER (Cytospora chrysosperma (Pers.) Fr.). Cytospora canker is common and very destructive to poplars in Montana. Kelsey (1889) reported it.

BLIGHT (Undetermined). A serious leaf and twig blight occurs on Populus tremuloides Michx. in Gallatin County.

CROWN GALL (Phytomonas tumefaciens (E.F.S. & Town.) Com. S.A.B.). Crown gall was reported by D. B. Swingle on Populus angustifolia James in Yellowstone County several years ago.

OTHER PARASITES

Achlya americana Humph. - (Graff, 1928).
Blastocladia ramosa Thax. - (Graff, 1928).
Cenangium sp. - Gallatin County, 1899.
Chlorosis (Physiological). Common and serious. Gallatin County.
Cryptosphaeria millepunctata Grev. - (Anderson, 1889).
Dermatea populina Schw. - (Kelsey, 1889).
Diatrype bullata (Hoff.) Fr. (In herbarium at Bozeman).
Dimerosporium populi E. & E. (Kelsey, 1889).
Fomes everhartii (E. & G.) Schrenk. (U.S.D.A. Bulletin 1366).
Hypocrea richardsoni B. & M. (Kelsey, 1889).
Marssonia castagnei (D. & M.) Sacc. Gallatin County. (Before 1928).
Melampsora albertensis Arth. (N.A.F. 7: 665). Gallatin and Ravalli Counties.
M. medusae Thuem. (Jones, 1910) et al. Bozeman, 1898.
M. occidentalis Jackson (N.A.F. 7:666).
M. populina (Jacq.) Lev. (Kelsey, 1889).
Phyllosticta brunnea Dearn. & Barth. (U.S.D.A. Bulletin 1366: N.A.F. 6: 70).
Septoria musiva Pk. (In Bozeman, 1928).
Uncinula salicis (DC.) Wint. (Kelsey, 1889).
Valsa nivea (Hoff.) Fr. (Gallatin County, 1899).
Zygodesmus obtusus E. & E. (Anderson, 1889).

## WILLOWS (Salix spp.)

Cenangium sp. Gallatin County, 1899.
Lachnella flammea (A. & S.) Fr. Gallatin County, 1898.
Marssonia apicaulis E. & E. Gallatin County, 1899.
Melampsora albertensis Arth. Gallatin County. Fungi Columbiani Nos.4329, 4548.
M. arctica Rostr. Gallatin County, 1898 and 1907.
M. bigelowii Thuem. Gallatin County, 1898. (N.A.F. 7: 100,666).
M. confluens (Pers.) Jackson. (N.A.F. 7:667). (Jones, 1910).
M. humboldtiana Speg. (N.A.F. 7:669).
M. salicina (Seymour, 1889).
M. salicis (Anderson, 1889).
M. salicis capreae (Pers.) Wint. at Helena, 1888.
Rhytisma salicinum Fr. (Kelsey, 1889). Gallatin County, 1900.
Septogloeum maculans. Hark. Gallatin County, 1925.
Septoria salicis Westd. Gallatin County.
Uncinula salicis (DC.) Wint. (Kelsey, 1889; Anderson, 1889).
Valsa salicina (Pers.) Fr. Gallatin County. (Before 1928).
Volutella occidentalis minor E. & A. (Ellis and Anderson, 1891).

## CONIFERS

### LIMBER PINES (Pinus flexilis James and P. albicaulis Engelm.)

Arceuthobium cyanocarpum Nels. Gallatin County.
Herpotrichia nigra Hart. Gallatin County.
Lophodermium pinastri (Schr.) Chev. Gallatin County.
Razoumofskya laricis Piper. (U.S.D.A. Bulletin 1366).

### WESTERN WHITE PINE (Pinus monticola Dougl.)

Dasyscypha fuscosanguinea Rehm. Mr. C. R. Stillinger, Associate Pathologist, U. S. Department of Agriculture, kindly loaned a manuscript in which he has described the ravages of this parasite. He found 50 per cent of the trees in one group damaged by Dasyscypha in Glacier National Park in 1921. It is a facultative parasite causing a disease with symptoms similar to those of blister rust.

Other parasites on western white pine are:
Lophodermium pinastri (Schrad.) Chev. (U.S.D.A. Bulletin 1366).
Rhizina inflata (Schaeff.) Sacc. (U.S.D.A. Bulletin 1366).
Sparassis radicata Weir. (U.S.D.A. Bulletin 1366).

### LODGEPOLE PINE (Pinus murrayana Oreg. Comm.)

Arceuthobium americanum Nutt. Gallatin County.
Coleosporium solidaginis (Schw.) Thuem. (U.S.D.A.Bulletin 1366 and N.A.F. 7:655.).
Cronartium coleosporioides (Diet. & Holw.) Arth. (U.S.D.A. Bulletin 1366).
C. harknessii (Moore) Mein. (U.S.D.A. Bulletin 1366).
C. pyriforme (Pk.) Hedgc. & Long. (U.S.D.A. Bulletin 1366).
C. stalactiforme Arth. Glacier County.
Didymosphaeria euryasca E. & G. (Anderson, 1889).
Fomes pinicola Fr. (U.S.D.A. Bulletin 1366).
Peridermium montanum A. & K. Gallatin County, 1900.
Rhizina inflata (Schaeff.) Sacc. (U.S.D.A. Bulletin 1366).
Trametes pini (Brot.) Fr. (U.S.D.A. Bulletin 1366).

### WESTERN YELLOW PINE (Pinus ponderosa Dougl.)

Arceuthobium americanum Nutt. (U.S.D.A. Bulletin 1366).
Cenangium abietis (Pers.) Rehm. (U.S.D.A. Bulletin 1366).
C. piniphilum Weir. (U.S.D.A. Bulletin 1366).
Cronartium pyriforme (Pk.) Hedgc. &. Long. (U.S.D.A. Bulletin 1366).

*Cronartium filamentosum* (Pk.) Hedgc. & Long. (U.S.D.A. Bulletin 1366).
*C. stalactiforme* Arth. (U.S.D.A. Bulletin 1366).
*Hypoderma deformans* Weir. (U.S.D.A. Bulletin 1366).
*Olpidium pendulum* Zopf. (Graff, 1928).
*Polyporus schweinitzii* Fr. (U.S.D.A. Bulletin 1366).
*Peridermium pini*. (Jones, 1910).
*Rhizina inflata* (Schaeff.) Sacc. (U.S.D.A. Bulletin 1366).
*Trametes pini* (Brot.) Fr. (U.S.D.A. Bulletin 1366).

### SPRUCES (*Picea pungens* Engelm. and *P. engelmannii* (Par.) Engelm.)

*Chrysomyxa weirii*. Jackson (N.A.F. 7:690).
*Echinodontium tinctorium* E. & E. (U.S.D.A. Bulletin 1366).
*Fomes pinicola* Fr. (U.S.D.A. Bulletin 1366).
*Herpotrichia nigra* Hart. Gallatin County.
*Melampsoropsis pyrolae* (DC.) Arth. (N.A.F. 7: 688).
*Peridermium coloradense* (Diet.) Arth. (N.A.F. 7:647).
*Razoumofskya douglasii microcarpa* Engelm. (U.S.D.A. Bulletin 1366).
*R. laricis* Piper. (U.S.D.A. Bulletin 1366).
*Sparassis radicata* Weir. (U.S.D.A. Bulletin 1366).
*Trametes pini* (Brot.) Fr. (U.S.D.A. Bulletin 1366).

### JUNIPERS (*Juniperus Spp.*)

*Cenangella deformata* (Pk.) Sacc. Madison County.
*Crucibulum vulgare* Tul. (Anderson, 1889).
*Herpotrichia nigra* Hart. Gallatin County.
*Gymnosporangium betheli* Kern. Gallatin County.
*G. clavariaeforme* (Jacq.) DC. (N.A.F. 7:825.)
*G. juvenescens* Kern. (N.A.F. 7:824).
*G. nelsoni* Arth. (N.A.F. 7:742).
*G. tubulatum* Kern. (N.A.F. 7:738).

### WESTERN LARCH (*Larix occidentalis* Nutt.)

*Dasyscypha fuscosanguinea* Rehm. Reported in Glacier National Park by C. R. Stillinger. (See western white pine).
*Fomes officinalis* Fr. (U.S.D.A. Bulletin 1366).
*Hypodermella laricis* Tub. (U.S.D.A. Bulletin 1366).
*Razoumofskya laricis* Piper (U.S.D.A. Bulletin 1366).
*Sparassis radicata* Weir. (U.S.D.A. Bulletin 1366).

### DOUGLAS FIR (*Pseudotsuga mucronata* (Raf.) Sudw.)

*Echinodontium tinctorium* E. & E. (U.S.D.A. Bulletin 1366).
*Fomes officinalis* Fr. (U.S.D.A. Bulletin 1366).
*Herpotrichia nigra* Hart. Gallatin County, 1925.
*Melampsora albertensis* Arth. (N.A.F. 7:665).
*Polyporus schweinitzii* Fr. (U.S.D.A.Bulletin 1366).
*Rhabdocline pseudotsugae* Syd. Gallatin County, 1928. (First Report).
*Sapromyces reinschii* (Schr.) Frit. (Graff, 1928).
*Sparassis radicata* Weir. (U.S.D.A. Bulletin 1366).
*Trametes pini* (Brot.) Fr. (U.S.D.A. Bulletin 1366).

### HEMLOCK (*Tsuga heterophylla* (Raf.) Sarg.)

*Echinodontium tinctorium* E. & E. (U.S.D.A. Bulletin 1366).
*Uredo holwayi* Arth. (N.A.F. 7:606).

### GIANT ARBORVITAE (*Thuja plicata* Donn.)

*Poria weirii* Murr. U.S.D.A. Bulletin 1366 reports it throughout range of host. This is a forest tree in western Montana.

### GREAT SILVER FIR (*Abies grandis* Lindl.)

*Calyptospora columnaris* (Alb. & Schw.) Kuehn. (U.S.D.A. Bulletin 1366).
*Echinodontium tinctorium* E. & E. (U.S.D.A. Bulletin 1366).
*Melampsora arctica* Rostr. (U.S.D.A. Bulletin 1366).
*Pucciniastrum pustulatum* (Pers.) Diet. (U.S.D.A. Bulletin 1366; N.A.F. 7:677).
*Rhizina inflata* (Schaeff.) Sacc. (U.S.D.A. Bulletin 1366).
*Uredinopsis pteridis* Diet. & Holw. (U.S.D.A. Bulletin 1366).

### ALPINE FIR (*Abies lasiocarpa* (Hook.) Nutt.)

*Calyptospora columnaris* (Alb. & Schw.) Kuehn. (N.A.F. 7: 682).
*Echinodontium tinctorium* E. & E. (U.S.D.A. Bulletin 1366).
*Melampsora arctica* Rostr. (U.S.D.A. Bulletin 1366).
*Melampsorella elatina* (Alb. and Schw.) Arth. (U.S.D.A. Bulletin 1366).
*Peridermium ornamentale* Arth. (N.A.F. 7:646).
*Pucciniastrum pustulatum* (Pers.) Diet. (N.A.F. 7:677).
*Razoumofskya laricis* Piper. (U.S.D.A. Bulletin 1366).

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### Explanation of Plate I.

A. Left, leaf of Bliss Triumph potato showing symptoms of curly mosaic. Right, leaf of a normal Bliss Triumph potato.

B. McIntosh apples showing nonparasitic cracking and dwarfing.

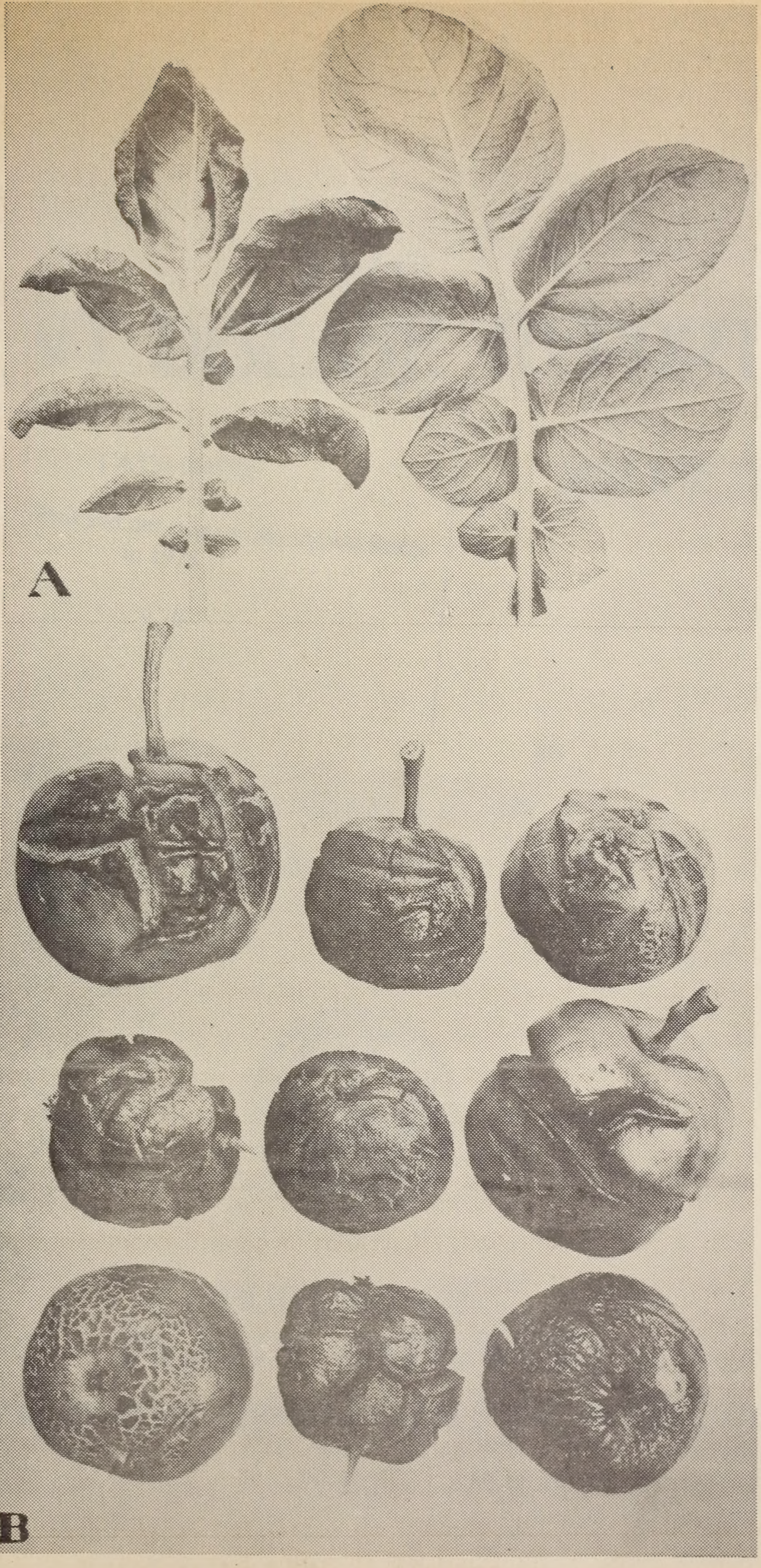

PLATE I